

# **1394 Analyzer Quickstart Guide**

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**FS3410bT, FS3470bT, FS3810, FS3811, FS3850, FS3851, FS3852**

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# Chapter 1. Introduction

Welcome to the 1394 Analyzer Quickstart Guide for the enter value here. For a quick start, please read the [Getting Started](#) chapter. If you need help installing the software, please refer to the [Installation](#) chapter.

The analyzer software contains the following functionality, which is explained in the corresponding chapters of the FireDiagnostics Suite Manual. Please be aware that available Analyzer Modules depend on the specific Analyzer model used.

- Monitor
- Recorder
- Symbol Recorder (licensed separately)
- Commander
- Generator
- Scriptor
- Filter/Trigger
- Mil1394 Signal Monitor (licensed separately)

The analyzer is in fact a protocol analyzer, which currently supports the following higher-level protocols:

- Automotive Multimedia Interface Collaboration (AMI-C)
- Serial Bus Protocol (SBP)
- Audio Video / Control Protocol (AV/C)
- Internet Protocol version 4 (IP4)
- Industrial / Instrumentation Digital Camera Protocol (IIDC)
- Mil1394 Protocol
- Custom Protocols

For information on the licensing model, please refer to the [License Manager](#) chapter.

## Chapter 2. Hardware

### 2.1. Gen4 Analyzer Series

The Gen4 Series of analyzers embodies a complete redesign of the well-known Advanced and Triple series analyzers. This brand-new line offers improved performance due to a more powerful embedded processor, the very latest FPGA technology and modern interfaces like USB3, enhanced Scriptor capabilities and more data capture memory.

The Gen4 Series uses a more powerful architectural design with two 667Mhz on-board ARM processors. It was designed with performance and flexibility in mind. Modularity not only results in several configuration options with respect to 1394 speeds, transformer coupling and host connectivity options but also results in the possibility of combining up-to 3 Triple FireSpy Mainboards (Units) into a full 9-bus IEEE-1394 analyzer. The FS9432bT/FS9832bT is the first Gen4 Series model released and several different configurations followed its initial release.

A standard off-the-shelf Physical Layer chip connects to a highly optimized FPGA which not only acts as a Link layer but also incorporates the data recording functionality, Trigger and Filter engines as well as the Data Monitor. Recorded data is directly captured into dedicated onboard data memory of 4GB per unit.

#### 2.1.1. FireSpy 3422bT, 3822bT

The FireSpy3x22bT bus analyzer series is world's only PCIe-based multi-channel FireWire bus analyzer product line. The different models differ only in their support for different speeds, architecturally they based on the latest Gen4 concept. Each analyzer card in fact combines three FireSpy analyzers in one single instrument.



The PCIe's format takes flexibility to a higher level and addresses the industries growing support for this data interface. This solution enables users to install the FireSpy hardware in any modern PC that has at least one 4-lane PCIe slot available. This allows for installation of the FireSpy in developers existing PCs or installing the analyzer in a rugged field service laptop or lunchbox computer.

The FireSpy3x22bT have three 1394 nodes connected to three synchronized analysis engines. They are controlled by a dual core ARM processor running at 667MHz. Each node is connected to two 1394 ports. Two ports of each 1394 node are connected to a LEMO connector.

The FireSpy3x22bT are equipped with 5 GB internal memory and extensive hardware filtering and trigger possibilities. The analyzer can be connected into a host computer using its PCIe interface. On the host you can control the FireSpy using a graphical user interface to analyze and display the bus traffic in a user-friendly way; or you can use the API to program your own control software.

### 2.1.1.1. Main Feature Summary

#### GENERAL

- IEEE 1394-2008 Beta compliant
- Supports S100-S800 transfer rates depending on exact model
- Connects to host using PCIe interface
- 5GByte memory for embedded OS and packet and data storage
- Firmware field upgradeable to enable future expansions
- AUX connector for:
  - Trigger input and output functions
  - Recording external events
  - Time synchronization
- GUI and API for Windows™ Operating Systems

#### MONITOR

- Displays bus activity:
  - isochronous packets
  - all types of asynchronous packets
  - all types of PHY packets
  - all types of acknowledge packets
  - several types of Errors
- Counts packets according to type, speed, ack and error condition
- Counts number of bus resets
- Measurement of bus power voltages (bilingual ports)

#### RECORDER

- Time stamping of all packets and status events with 10ns resolution
- Packets hidden by slower connections are visible as 'prefix only' packets
- Extensive packet/event filtering/trigger/search capabilities
  - Packet type
  - Transmission speed
  - Boolean combination of 4 programmable packet sets
  - Data payload patterns
  - Error conditions
  - Various status events
  - Graphical Trigger Sequencer
- Adjustable trigger position within programmable record buffer size
- Cyclic pre-trigger buffer management option
- Different kinds of packet display views, including:
  - Time View, displays all packets on a time line, including the prefix
  - Packet View, displays packets as list plus selected packet options
  - Transaction View, displays transactions as list or flow graph
  - Topology View, graphical topology displays as is during recording
  - Protocol View, displays packets decoded to selected protocol
- Precise time measurements
- Marking of individual packets or packet ranges
- Export format for re-generation of packets by Scriptor or API

#### GENERATOR

- Simultaneous generation of up to 63 iso streams on 9 buses
  - Graphically programming of stream transmit block
  - Data payload import from file
- Generator and Scriptor run simultaneous for stream and asynchronous
  - packet generation
- Special AS5643 stream generator package (optional)

#### SCRIPTOR

- Script Editor
  - C-like scripting language

- Function Library
- Macros to automatically generate blocks of code
- Syntax coloring
- Integrated Debugger
- Floating point data types
- Data Editor
- Control Panel
  - Graphical display elements for data value representation
  - Ethernet-connected Client Panels for remote data monitoring
- Several Sample Scripts

### COMMANDER

- Reading and/or writing of local and reading of remote PHY registers
- Reading and/or writing of remote memory locations (incl. CSR register space)
- Possibility to graphically view the current Topologies
- Sending of user definable packets

#### 2.1.1.2. Specifications

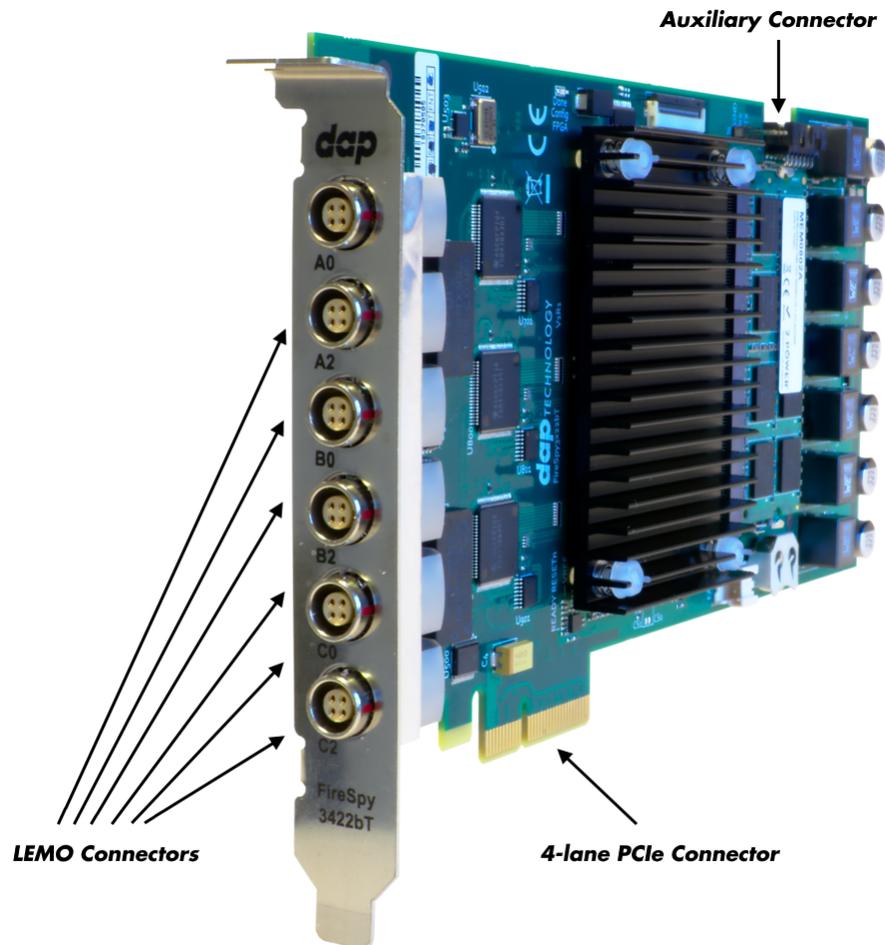
<b>Dimensions:</b>	4-lane PCIe: card length approx. 205 mm
<b>Weight:</b>	TBD
<b>Operating Range:</b>	0 – 70 C
<b>Power Requirements:</b>	25Watt max.
<b>Compliance:</b>	FCC Class A
<b>Connections:</b>	<ul style="list-style-type: none"> <li>● PCIe connector</li> <li>● 6x LEMO connectors</li> <li>● Auxiliary connector</li> </ul>
<b>Indicators:</b>	-
<b>Switches:</b>	-
<b>Package Content:</b>	FireSpy3x22bT 3x LEMO to Bilingual cables
<b>Product warranty:</b>	24 months limited warranty
<b>Part Number:</b>	FS3822bT or FS3822bTAS5643 analyzer with AS5643 SW protocol package FS3422bT or FS3422bTAS5643 analyzer with AS5643 SW protocol package
<b>Optional Configuration:</b>	N/A
<b>SW Add-on modules:</b>	SBP2 protocol software package IIDC protocol software package AV/C protocol software package IP1394 protocol software package AS5643 protocol software package AMI-C protocol software package

### FCC Class A Compliance

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Modifications not expressly approved by the manufacturer could void the user's authority to operate the equipment under FCC rules.

### 2.1.1.3. FireSpy PCI Board



#### LEMO Connectors

With these connectors the FireSpy can be connected to the IEEE1394 bus to be analyzed. Each connector may be connected to the bus. The IEEE1394b ports are (from left to right) A0, A2, B0, B2, C0, C2.

Each connector is transformer coupled.

#### Auxiliary Connector

The auxiliary port will be discussed in a separate chapter. See [Auxiliary connector ports](#).

### 2.1.2. FireSpy 4430b, 4430bT, 4830, 4830bT

The FireSpy4x30xx bus analyzer is world's only four-node IEEE-1394 bus analyzer. Based on the 4th generation FireSpy analyzer architecture the FireSpy4x30xx is the most advanced 1394 test equipment in the market. The FireSpy4x30xx in fact combines four FireSpy analyzers in one single instrument. It comprises a significantly more powerful on-board processor and improved connectivity to the host.



The FireSpy4x30xx has four 1394 nodes connected to four synchronized analysis engines. They are controlled by two dual core ARM processors running at 667MHz. Each node is connected to three 1394 ports. All ports of each node are connected to a separate IEEE-1394 connector with screw mount holes which was chosen over standard 1394 connectors for improved ruggedness.

The FireSpy4x30xx is equipped with 10 GB internal memory and extensive hardware filtering and trigger possibilities. The analyzer can be connected to a host computer using the USB3 interface. On the host you can control the FireSpy using a graphical user interface to analyze and display the bus traffic in a user-friendly way; or you can use the API to program your own control software.

The seamless integration of the SAE AS5643 protocol makes the FireSpy4x30xx the preferred tool for many Aerospace & Defense development tasks. DapTechnology has taken considerable efforts to fully support the AS5643 protocol in all major functional areas of the FireSpy4x30xx and continuously updates the analyzer functionality according to implementation requirements and ongoing standardization efforts.

### 2.1.2.1. Main Feature Summary

#### GENERAL

- IEEE 1394-2008 Beta compliant
- Supports S100B-S800B transfer rates depending on exact model
- Connects to host using USB3.0 interface
- 10GByte memory for embedded OS and packet and data storage
- Firmware field upgradeable to enable future expansions
- AUX connector for:
  - Trigger input and output functions
  - Recording external events
- Software runs on Windows™ Operating Systems

#### MONITOR

- Displays bus activity:
  - isochronous packets
  - all types of asynchronous packets
  - all types of PHY packets
  - all types of acknowledge packets
  - several types of Errors
- Counts packets according to type, speed, ack and error condition
- Counts number of bus resets

#### RECORDER

- Time stamping of all packets and status events with 10ns resolution
- Packets hidden by slower connections are visible as 'prefix only' packets

- Extensive packet/event filtering/trigger/search capabilities
  - Packet type
  - Transmission speed
  - Boolean combination of 4 programmable packet sets
  - Data payload patterns
  - Error conditions
  - Various status events
  - Graphical Trigger Sequencer
- Adjustable trigger position within programmable record buffer size
- Cyclic pre-trigger buffer management option
- Different kinds of packet display views, including:
  - Time View, displays all packets on a time line, including the prefix
  - Packet View, displays packets as list plus selected packet options
  - Transaction View, displays transactions as list or flow graph
  - Topology View, graphical topology displays as is during recording
  - Protocol View, displays packets decoded to selected protocol
- Precise time measurements
- Marking of individual packets or packet ranges
- Export format for re-generation of packets by Scriptor or API

### **GENERATOR**

- Simultaneous generation of up to 63 iso streams on 4 buses
  - Graphically programming of stream transmit block
  - Data payload import from file
- Generator and Scriptor run simultaneous for stream and asynchronous
  - packet generation
- Special AS5643 stream generator package (optional)

### **SCRIPTOR**

- Script Editor
  - C-like scripting language
  - Function Library
  - Macros to automatically generate blocks of code
  - Syntax coloring
  - Integrated Debugger
  - Floating point data types
- Data Editor
- Control Panel
  - Graphical display elements for data value representation
  - Ethernet-connected Client Panels for remote data monitoring
- Several Sample Scripts

### **COMMANDER**

- Reading and/or writing of local and reading of remote PHY registers
- Reading and/or writing of remote memory locations (incl. CSR register space)
- Possibility to graphically view the current Topologies
- Sending of user definable packets

### 2.1.2.2. Specifications

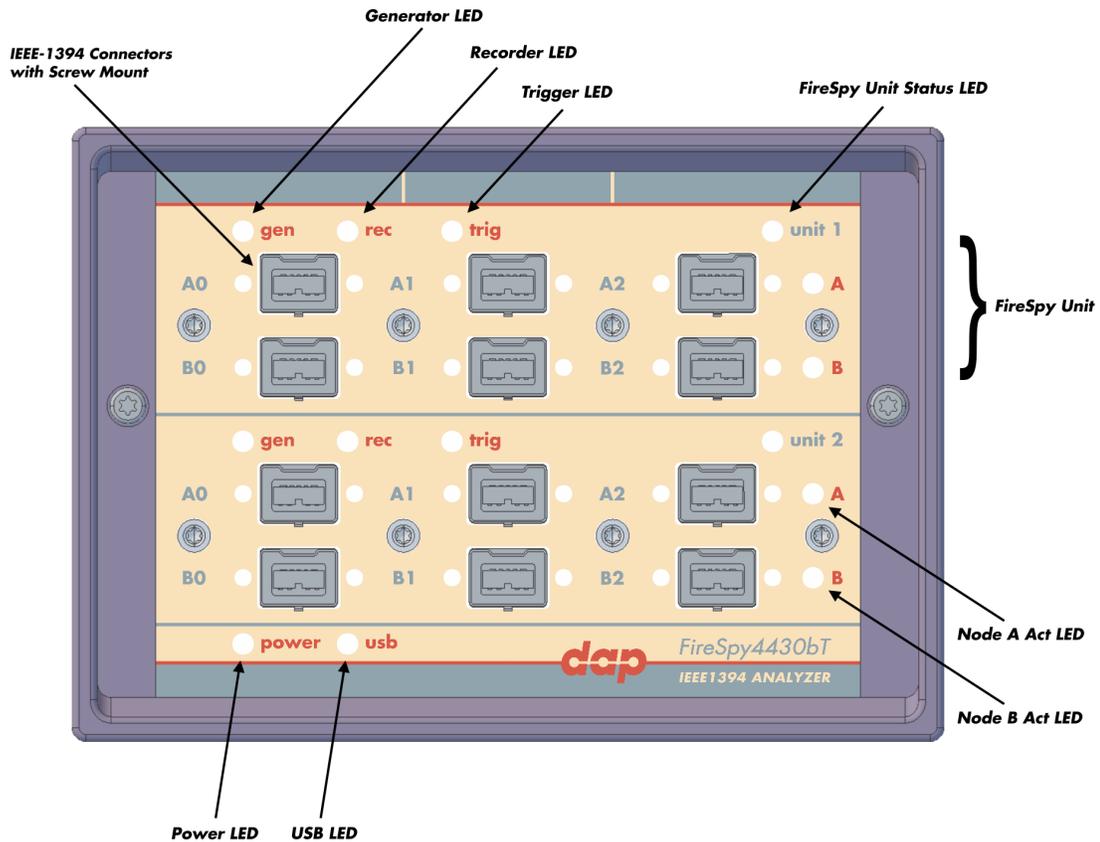
<b>Dimensions:</b>	125 mm x 96 mm x 301 mm
<b>Weight:</b>	2070 g
<b>Operating Range:</b>	0 – 45 C
<b>Power Requirements:</b>	12 V, 40Watt max.
<b>Compliance:</b>	FCC Class A
<b>Connections:</b>	<ul style="list-style-type: none"> <li>• USB 3.0 connector for host-computer</li> <li>• 12x IEEE-1394 connectors with screw holes</li> <li>• Auxiliary connector</li> <li>• Power connector</li> </ul>
<b>Indicators:</b>	<ul style="list-style-type: none"> <li>• Multi-colored LEDs for: Unit status, Recorder, Generator, Trigger, Active (per node)</li> <li>• Green LEDs for: USB, Power</li> </ul>
<b>Switches:</b>	Toggle switch for Power On/Off
<b>Package Content:</b>	FireSpy4x30xx Power Adapter (12V, 5A) USB 3.0 Cable
<b>Product warranty:</b>	24 months limited warranty
<b>Part Number:</b>	FS4430bT or FS4430bTAS5643 analyzer with AS5643 SW protocol package
<b>Optional Configuration:</b>	N/A
<b>SW Add-on modules:</b>	SBP2 protocol software package IIDC protocol software package AV/C protocol software package IP1394 protocol software package AS5643 protocol software package AMI-C protocol software package

#### FCC Class A Compliance

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Modifications not expressly approved by the manufacturer could void the user's authority to operate the equipment under FCC rules.

### 2.1.2.3. FireSpy Front



#### Generator LED

This LED will light up green while the FireSpy Generator is active. See Generator.

#### Recorder LED

This LED will light up red while recording is in progress. After the recording stops it will be orange during the post-processing phase. As soon as data is ready for download to the host, the LED will turn green. See Recorder.

#### Trigger LED

This LED will light up green while the Trigger/Sequencer is active but not yet triggered. When the Trigger occurs, the LED turns red. See Filter/Trigger.

#### FireSpy Unit

This FireSpy model consists of two double FireSpy Analyzer Units to form a total of 4 analyzer nodes. Each Unit has its own section on the front panel with connectors and status LEDs. Units are numbered top-down from 1 to 2. The FireSpy application can be used to control one unit at a time or multiple units simultaneously.

#### FireSpy Unit Status LED

This led will light up orange when the FireSpy Unit is switched on but not yet configured. The bootloader will configure the device with the firmware version last used. When configuration is successful the LED will turn green. A red LED indicates an error.

#### Node A and B Act LEDs

(Not yet implemented) The function of these LEDs can be configured through the settings dialog of the FireSpy Application. These LEDs can also be controlled by the FireSpy Scriptor.

#### Power LED

The Power LED will light up red when power is supplied to the power connector on the back. Please be aware that this LED also lights up when the Power Switch on the back is in the Off position.

### USB LED

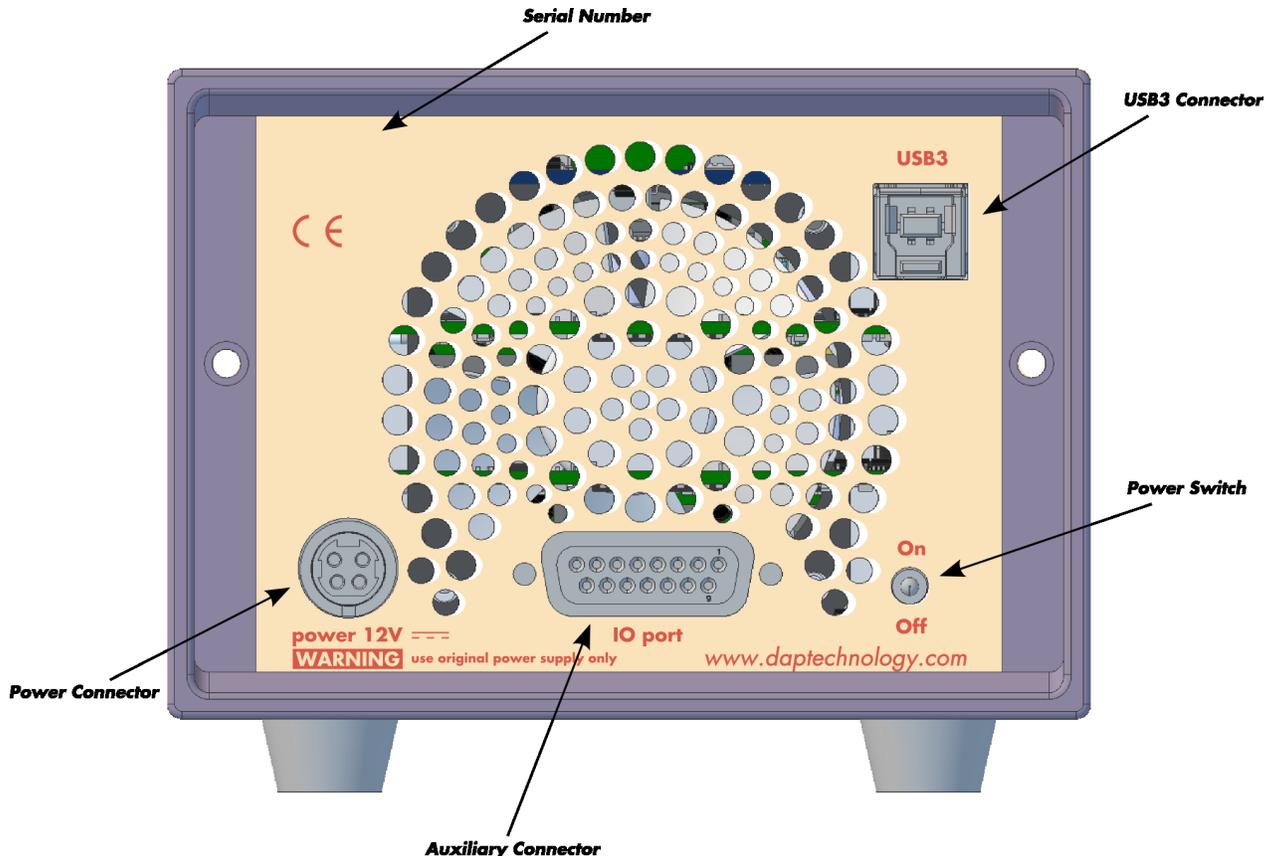
The USB LED will light up when the FireSpy is connected to the USB port of your computer (see 'FireSpy Rear' below) and the computer is switched on. It indicates the availability of USB bus power.

### IEEE-1394 Connectors

With these connectors the FireSpy can be connected to the IEEE1394 bus to be analyzed. Each connector may be connected to the bus. The IEEE1394b ports are (top-down, left-right) A0, A1, A2, B0, B1, B2.

Depending on the exact model, each connector is transformer coupled.

#### 2.1.2.4. FireSpy Rear



### Power Switch

Using this switch the FireSpy can be switched on and off. When switched on, the Unit LEDs on the front panel will light up orange to indicate they are starting up. Note that the power supply needs to be connected to the FireSpy (see below) to be able to switch the FireSpy on.

### Power Connector

The power supply must be connected to the FireSpy, using this connector. Note that, for safety reasons, only the original power supply should be used. Whenever power is supplied to the analyzer, the Power LED on the front panel will light up red. (Even when the Power Switch is in the Off position).

### Auxiliary Connector

The auxiliary port will be discussed in a separate chapter. See [Auxiliary connector ports](#).

### USB3 Connector

The FireSpy must be connected to the computer using this connector. A USB3 cable, which is part of the FireSpy-package, is connected between this connector and the USB3 port of the computer.

### Serial Number

Each FireSpy has an 11-character serial number. This number is also programmed into the FireSpy and can be read with the License Manager of the FireSpy application. The software will only work when a valid license certificate is installed for the serial number of the currently connected FireSpy. See [License Manager](#) for more information on license certificates.

## 2.2. Triple Series

Utilizing the restructured hardware architecture of the FS810, both the FS3x10 and FS385x offer the industry's first 3 channel data analysis capability. And multiple units can be chained together to build a synchronized 3, 6 or 9 channel system.

The Triple Series uses an more powerful architectural design with a 400MHz on-board PowerPC. Three off-the-shelf Physical Layer chips connect to a highly optimized FPGA which not only acts as Link layers but also incorporate three completely independent data recording functions, Trigger and Filter engines as well as Data Monitors. Recorded data are directly captured into onboard memory (1GB).

The user can easily connect the analyzer to his PC (laptop) via a USB2.0 or Ethernet connection (or a PCI interface). All data transfer to the PC is offline, so there is no potential for the loss of data.

FireSpys from the Triple Series are also available in a PCI (FS385x) and in CompactPCI (FS3470) configuration.

### 2.2.1. FireSpy 3810, 3811,3410bT(1)

The FireSpy3810 bus analyzer is the first in a new generation of FireWire analyzers from DapTechnology. Based on the industry leading FireSpy800 and the new FireSpy3810 architecture the FireSpy3810 is the most advanced IEEE 1394 test equipment in the market. The FireSpy3810 in fact combines three FireSpy analyzers in one single instrument. It comprises a significantly more powerful on-board processor and improved connectivity to the host. With the new scripting engine the FireSpy3810 can also be used as a stand-alone analyzer.

The FireSpy3810 has three 1394 nodes connected to three synchronized analysis engines. They are controlled by a RISC processor running at 400 MHz. Each node is connected to three FireWire ports. One port of each node is connected to an individual standard bilingual FireWire connector. The other two ports of each node are connected to one high density, high speed connector and include active transformer coupling. A cable converting to 6 Beta connectors is provided.

The FireSpy3810 is equipped with 1024 MB internal memory and extensive hardware filtering and trigger possibilities. The analyzer can be connected to a host computer using the USB or Ethernet interface. On the host you can control the FireSpy using a graphical user interface to analyze and display the bus traffic in a user-friendly way; or you can use the API to program your own control software.

#### 2.2.1.1. Main Feature Summary

##### General

- IEEE 1394-1995, 1394a-2000 and 1394b-2002 compliant
- FS3810,FS3811: Supports 100(L), 200(L), 400(L&B) and 800(B) Mbps connection speeds
- FS3410bT: Supports 200(B) and 400(B) Mbps connection speeds
- FS3410bT(1): Supports 100(B) and 200(B) Mbps connection speeds
- Connects to host using USB2.0 interface or to LAN via 10/100 BaseT
- Electrical isolation between IEEE 1394 and host (USB)
- Optional Bus Power: 2.8 Watts at 12 Volt (for each bilingual port)
- 992 MByte memory for packet and data storage
- Firmware field upgradeable to enable future expansions
- AUX connector for:
  - Trigger input and output functions
  - Recording external event
- Software runs on Windows™ XP and Windows™ 7

##### Monitor

- Displays bus activity:
  - isochronous packets
  - all types of asynchronous packets
  - all types of PHY packets
  - all types of acknowledge packets
  - several types of Errors
- Counts packets according to type, speed, ack and error condition
- Counts number of bus resets
- Measurement of bus power voltages (bilingual ports)

### **Recorder**

- Time stamping of all packets and status events with 10ns resolution
- Packets hidden by slower connections are visible as 'prefix only' packets
- Extensive packet/event filtering/trigger/search capabilities
  - Packet type
  - Transmission speed
  - Boolean combination of 4 programmable packet sets
  - Data payload patterns
  - Error conditions
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  - Graphical Trigger Sequencer
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- Different kinds of packet display views, including:
  - Time View, displays all packets on a time line, including the prefix
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  - Topology View, graphical topology displays as is during recording
  - Protocol View, displays packets decoded to selected protocol
- Precise time measurements
- Marking of individual packets or packet ranges
- Export format for re-generation of packets by Scriptor or API

### **Generator**

- Simultaneous generation of up to 63 iso streams
  - Graphically programming of stream transmit block
  - Data payload import from file
- Generator and Scriptor run simultaneously for stream and asynchronous packet generation
- Special AS5643 stream generator package (optional)

### **Scriptor**

- Script Editor
  - C-like scripting language
  - Function Library
  - Macros to automatically generate blocks of code
  - Syntax coloring
  - Integrated Debugger
  - Floating point data types
- Data Editor
- Control Panel
  - Graphical display elements for data value representation
  - Ethernet-connected Client Panels for remote data monitoring
- Several Sample Scripts

### **Commander**

- Reading and/or writing of local and reading of remote PHY registers
- Reading and/or writing of remote memory locations (incl. CSR register space)
- Possibility to graphically view the current Topologies
- Sending of user definable packets

### 2.2.1.2. Specifications

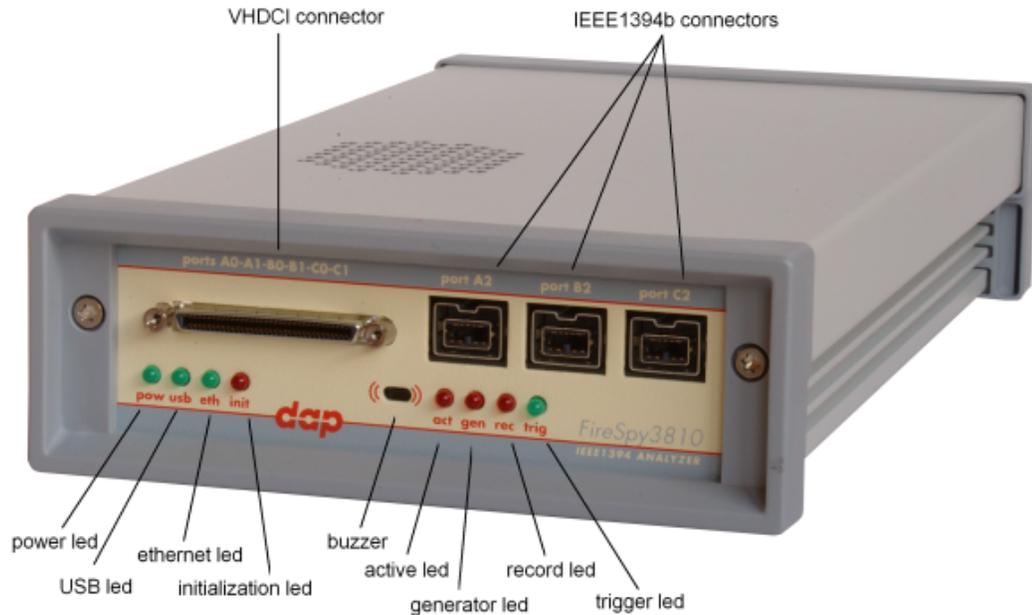
<b>Dimensions:</b>	125 mm x 48 mm x 209 mm
<b>Weight:</b>	800 g
<b>Operating Range:</b>	0 – 45 C
<b>Power Requirements:</b>	12 V, 10 Watt maximum (without providing 1394 bus power)
<b>Compliance:</b>	FCC Class A
<b>Connections:</b>	USB2.0-connector for host-computer RJ45 Ethernet connector For FS3810, FS3410bT(1): <ul style="list-style-type: none"> <li>• high-density connector (VHDCI) for 6 transformer coupled 1394Beta connections</li> <li>• 3 IEEE 1394-connectors (bilingual)</li> </ul> For FS3811: <ul style="list-style-type: none"> <li>• 6 IEEE 1394-connectors (bilingual)</li> </ul>
<b>Indicators:</b>	Green LEDs for: USB, Power, Ethernet, Trigger Red LEDs for: Record, Scriptor Active, Generate Buzzer
<b>Switches:</b>	Tumble switch for Power On/Off Push button for manual triggering
<b>Package Content:</b>	FireSpy Power Adapter (12V, 2500mA) USB Cable 2.0 For FS3810, FS3410bT(1): <ul style="list-style-type: none"> <li>• 3x 1394b Cable (Beta9 – Beta9)</li> <li>• Adapter Cable (VHDCI – 1394Beta (x6))</li> </ul> For FS3811: <ul style="list-style-type: none"> <li>• 3x 1394b Cable (Bilingual 9 – 9)</li> </ul>
<b>Product warranty:</b>	24 months limited warranty
<b>Part Number:</b>	FS381 or FS381AS5643 (S800 w. AS5643 SW protocol package) FS341 or FS341AS5643 (S400 w. AS5643 SW protocol package)
<b>Optional Configuration:</b>	FS3811 (no transformers, 6 bilingual ports) FS3410bT1 (S100-S200 transformers)
<b>SW Add-on modules:</b>	SBP2 protocol software package IIDC protocol software package AV/C protocol software package IP1394 protocol software package AS5643 protocol software package

### FCC Class A Compliance

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Modifications not expressly approved by the manufacturer could void the user's authority to operate the equipment under FCC rules.

### 2.2.1.3. FS3810 and FS3410bT(1) Front



#### VHDCI connector

This connector is a 68 pins connector. It encompasses the transformer coupled IEEE1394b ports A0, A1, B0, B1, C0, C1 and a 6 aux port signals.

The auxiliary port will be discussed in a separate chapter. See [Auxiliary connector ports](#).

#### power led

This green led will light up when the power supply is connected to the FireSpy (see 'FireSpy 3810 Rear' below) and the FireSpy is switched on. It indicates the availability of power from the power supply

#### USB led

This green led will light up when the FireSpy is connected to the USB port of your computer (see 'FireSpy 3810 Rear' below) and the computer is switched on. It indicates the availability of USB bus power.

#### ethernet led

This green led will light up when the FireSpy is connected through its ethernet port (see 'FireSpy 3810 Rear' below) and the network is active.

#### The initialization led

This red led will light up when the FireSpy is performing an initialization of the firmware.

#### IEEE1394b connectors (3x)

With these connectors the FireSpy 3810 can be connected to the IEEE1394 bus to be analyzed. Each connector may be connected to the bus. Each connector is not connected to either of the other two ports. The IEEE1394b ports are (from left to right) port A2, port B2 and port C2.

Each connector is bilingual. This means that they can be connected to a 1394b (beta) port or to a 1394a (legacy) port (FS381x only), by using the correct cables.

#### buzzer opening

Behind this hole a buzzer is installed.

#### active led

This red led will light up when the Scriptor is active. See Scriptor.

#### **generator led**

This red led will light up when the FireSpy Generator is active. See Generator.

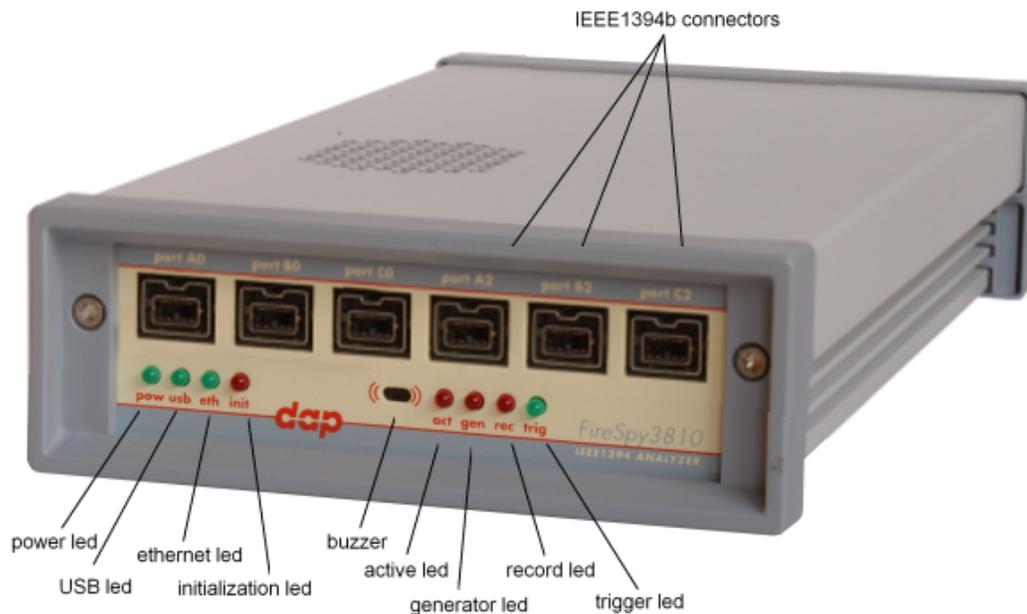
#### **record led**

This red led will light when recording is in progress. See Recorder.

#### **trigger led**

This green led will light up when the FireSpy Recorder has been triggered. See Recorder.

### 2.2.1.4. FS3811 Front



#### **power led**

This green led will light up when the power supply is connected to the FireSpy (see 'FireSpy Rear' below) and the FireSpy is switched on. It indicates the availability of power from the power supply

#### **USB led**

This green led will light up when the FireSpy is connected to the USB port of your computer (see 'FireSpy Rear' below) and the computer is switched on. It indicates the availability of USB bus power.

#### **ethernet led**

This green led will light up when the FireSpy is connected through its ethernet port (see 'FireSpy Rear' below) and the network is active.

#### **The initialization led**

This red led will light up when the FireSpy is performing an initialization of the firmware.

#### **IEEE1394b connectors (6x)**

With these connectors the FireSpy 3811 can be connected to the IEEE1394 bus to be analyzed. Each connector may be connected to the bus. The IEEE1394b ports are (from left to right) A0, A1, B0, B1, C0, C1.

Each connector is bilingual. This means that they can be connected to a 1394b (beta) port or to a 1394a (legacy) port, by using the correct cables.

#### **buzzer opening**

Behind this hole a buzzer is installed.

#### **active led**

This red led will light up when the Scriptor is active. See Scriptor.

#### **generator led**

This red led will light up when the FireSpy Generator is active. See Generator.

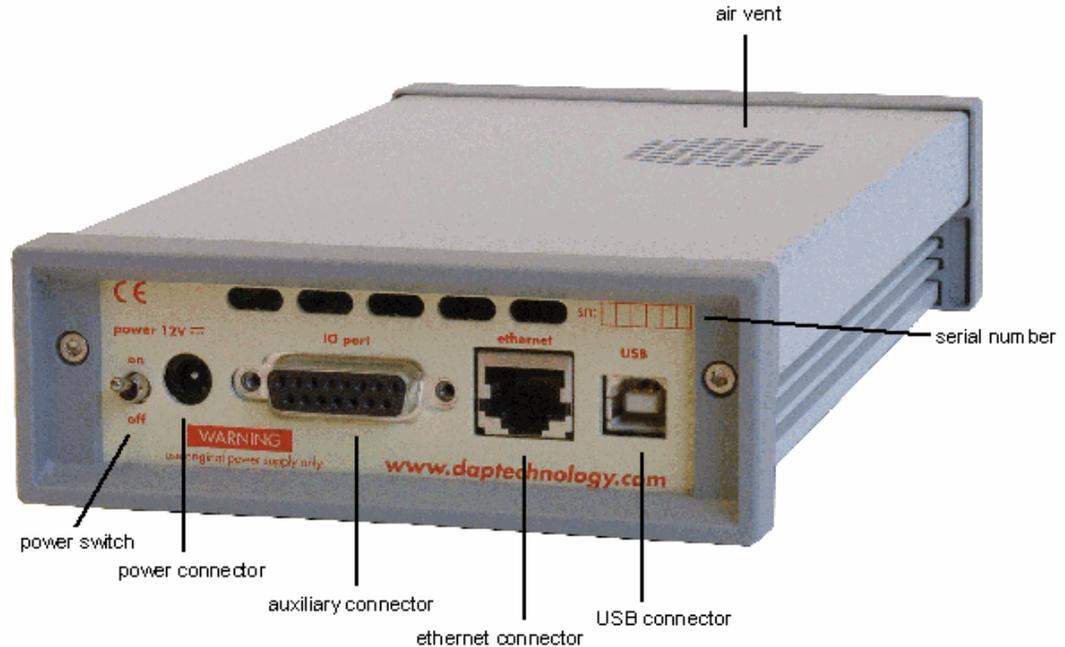
#### **record led**

This red led will light when recording is in progress. See Recorder.

#### **trigger led**

This green led will light up when the FireSpy Recorder has been triggered. See Recorder.

### **2.2.1.5. FireSpy Rear**



#### **power switch**

Using this switch the FireSpy can be switched on (powered) and off. When switched on the 'power led' on the front will light up. Note that the power supply needs to be connected to the FireSpy (see below) to be able to switch the FireSpy on.

#### **power connector**

The power supply must be connected to the FireSpy, using this connector. Note that, for safety reasons, only the original power supply should be used.

#### **auxiliary connector**

The auxiliary port will be discussed in a separate chapter. See [Auxiliary connector ports](#).

#### **ethernet connector**

This is a standard ethernet port. it is used for network access to the FireSpy 3810.

### USB connector

The FireSpy must be connected to the computer using this connector. A USB cable, which is part of the FireSpy-package, is connected between this connector and the USB port of the computer.

The USB interface is electrically isolated from the IEEE1394b logic to prevent ground loops.

### serial number

Each FireSpy has a 5 character serial number. This number is also programmed into the FireSpy and can be read with the License Manager of the FireSpy application. Part of the software will only work when license keys are installed for the serial number of the currently connected FireSpy. See [License Manager](#) for more information on license keys.

## 2.2.2. FireSpy 3850, 3851

The FireSpy385x bus analyzer is world's only PCI –based multichannel FireWire bus analyzer. Based on the industry leading FireSpy810 architecture the FireSpy385x is the most advanced IEEE 1394 test equipment in the market. The FireSpy385x in fact combines three FireSpy analyzers in one single instrument. It comprises a significantly more powerful on-board processor and improved connectivity to the host.

The PCI format takes flexibility to a higher level. This solution enables users to install the FireSpy hardware in any PC that has at least one PCI slot available. This allows for installation of the FireSpy in developers existing PC's or installing the analyzer in a rugged field service laptop or lunchbox computer.

The FireSpy385x has three 1394 nodes connected to three synchronized analyzer engines. They are controlled by an onboard RISC processor running at 400 MHz. Each node is connected to three FireWire ports. One port of each node is connected to a separate standard bilingual FireWire connector. The other two ports of each node are connected to one high speed connector and include active transformer coupling.

The FireSpy385x is equipped with 1 GByte memory and extensive hardware filtering and trigger capabilities. On the host you can control the FireSpy using a graphical user interface to analyze and display the bus traffic in a user-friendly way, or you can use the API and program your own control software.

The seamless integration of the SAE AS5643 protocol makes the FireSpy385x the preferred tool for many Aerospace & Defense development tasks. DapTechnology has taken considerable efforts to fully support the SAE AS5643 protocol in all major functional areas of the FireSpy385x and continuously updates the analyzer functionality according to implementation requirements and ongoing standardization efforts.

### 2.2.2.1. Main Feature Summary

#### General

- IEEE 1394-1995, 1394a-2000 and 1394b-2002 compliant
- Supports 100(L), 200(L), 400(L&B) and 800(B) Mbps transfer rates
- PCI 2.1 compliant
- Optional Bus Power: 2.8 W at 12V (for each bilingual port)
- 992 MByte memory for packet and data storage
- Firmware field upgradeable to enable future expansions
- AUX connector for:
  - Trigger input and output functions
  - Recording external event
- Software runs on Windows™ XP and Windows™ 7

#### Monitor

- Displays bus activity:
  - isochronous packets
  - all types of asynchronous packets
  - all types of PHY packets
  - all types of acknowledge packets

- several types of Errors
- Counts packets according to type, speed, ack and error condition
- Counts number of bus resets
- Measurement of bus power voltages (bilingual ports)

### Recorder

- Time stamping of all packets and status events with 10ns resolution
- Packets hidden by slower connections are visible as 'prefix only' packets
- Extensive packet/event filtering/trigger/search capabilities
  - Packet type
  - Transmission speed
  - Boolean combination of 4 programmable packet sets
  - Data payload patterns
  - Error conditions
  - Various status events
  - Graphical Trigger Sequencer
- Adjustable trigger position within programmable record buffer size
- Cyclic pre-trigger buffer management option
- Different kinds of packet display views, including:
  - Time View, displays all packets on a time line, including the prefix
  - Packet View, displays packets as list plus selected packet options
  - Transaction View, displays transactions as list or flow graph
  - Topology View, graphical topology displays as is during recording
  - Protocol View, displays packets decoded to selected protocol
- Precise time measurements
- Marking of individual packets or packet ranges
- Export format for re-generation of packets by Scriptor or API

### Generator

- Simultaneous generation of up to 63 iso streams
  - Graphically programming of stream transmit block
  - Data payload import from file
- Generator and Scriptor run simultaneous for stream and asynchronous packet generation
- Special AS5643 stream generator package (optional)

### Scriptor

- Script Editor
  - C-like scripting language
  - Function Library
  - Macros to automatically generate blocks of code
  - Syntax coloring
  - Integrated Debugger
  - Floating point data types
- Data Editor
- Control Panel
  - Graphical display elements for data value representation
  - Ethernet-connected Client Panels for remote data monitoring
- Several Sample Scripts

### Commander

- Reading and/or writing of local and reading of remote PHY registers
- Reading and/or writing of remote memory locations (incl. CSR register space)
- Possibility to graphically view the current Topologies
- Sending of user definable packets

### 2.2.2.2. Specifications

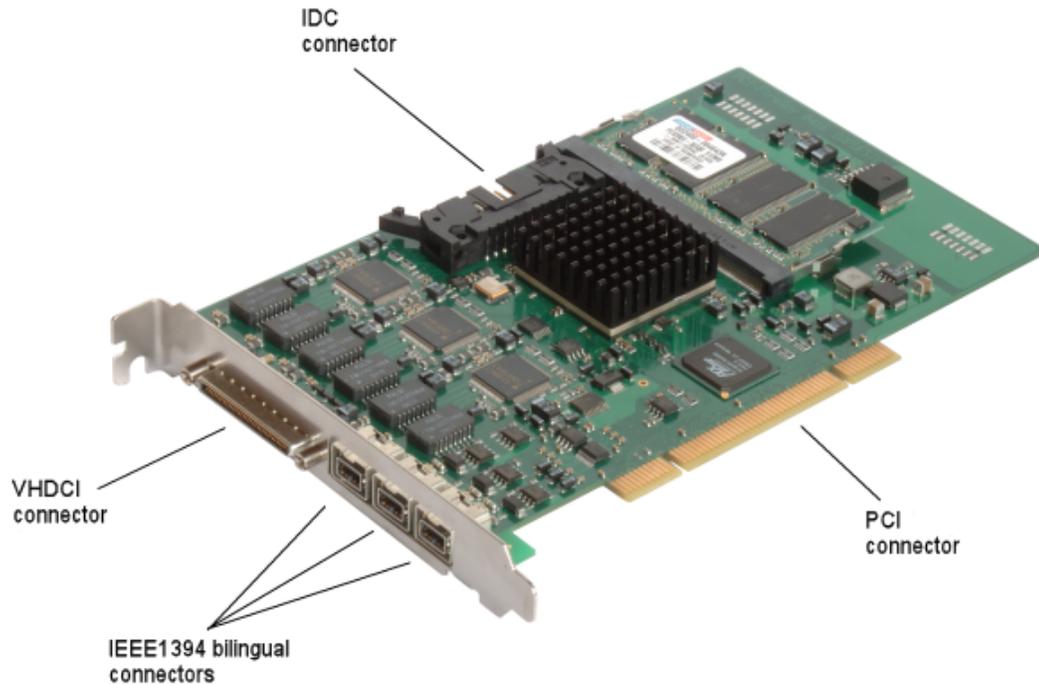
<b>Dimensions:</b>	Half Length PCI, 125 mm x 48 mm x 209 mm
<b>Weight:</b>	150 g
<b>Operating Range:</b>	0 – 70 C
<b>Power Requirements:</b>	12 V, 10 Watt maximum (without providing 1394 bus power)
<b>Compliance:</b>	FCC Class A
<b>Connections:</b>	<ul style="list-style-type: none"><li>• 32bit/33MHz PCI connector, universal keyed (for 3.3V and 5V slots)</li><li>• 3 IEEE 1394-connectors (bilingual)</li><li>• high-density connector (VHDCI) for 6 transformer coupled 1394Beta connections</li></ul>
<b>Indicators:</b>	-
<b>Switches:</b>	-
<b>Package Content:</b>	<ul style="list-style-type: none"><li>• FireSpy</li><li>• 3x 1394b Cable (Beta9 – Beta9)</li><li>• Adapter Cable (VHDCI – 1394Beta (x6))</li></ul>
<b>Product warranty:</b>	24 months limited warranty
<b>Part Number:</b>	FS385 or FS385AS5643 (w. AS5643 SW protocol package)
<b>SW Add-on modules:</b>	SBP2 protocol software package IIDC protocol software package AV/C protocol software package IP1394 protocol software package AS5643 protocol software package

#### FCC Class A Compliance

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Modifications not expressly approved by the manufacturer could void the user's authority to operate the equipment under FCC rules.

### 2.2.2.3. The FS3850, FS3851 PCI board



This FireSpy is a PCI card. It must be build into a PC.

#### **IDC connector**

The IDC connector is an auxiliary port. The auxiliary port will be discussed in a separate chapter. See [Auxiliary connector ports](#).

#### **VHDCI connector**

This connector is a 68 pins connector. It encompasses the transformer coupled IEEE1394b ports A0, A1, B0, B1, C0, C1 and a 6 aux port signals.

The auxiliary port will be discussed in a separate chapter. See [Auxiliary connector ports](#).

#### **IEEE1394bilingual connectors (3x)**

With these connectors the FireSpy 3850 can be connected to the IEEE1394 bus to be analyzed. Each connector may be connected to the bus. Each connector is not connected to either of the other two ports. The IEEE1394 ports are (from left to right) port A2, port B2 and port C2.

Each connector is bilingual. This means that they can be connected to a 1394b (beta) port or to a 1394a (legacy) port, by using the correct cables.

#### **PCI connector**

The PCI connector is the connection between this FireSpy and the computer it is to work with. Place the connector into an empty PCI slot in the computer.

## 2.2.3. FireSpy 3852

The FireSpy385x bus analyzer is world's only PCI –based multichannel FireWire bus analyzer. Based on the industry leading FireSpy810 architecture the FireSpy385x is the most advanced IEEE 1394 test equipment in the market. The FireSpy385x in fact combines three FireSpy analyzers in one single instrument. It comprises a significantly more powerful on-board processor and improved connectivity to the host.

The PCI format takes flexibility to a higher level. This solution enables users to install the FireSpy hardware in any PC that has at least one PCI slot available. This allows for installation of the FireSpy in developers existing PC's or installing the analyzer in a rugged field service laptop or lunchbox computer.

The FireSpy385x has three 1394 nodes connected to three synchronized analyzer engines. They are controlled by an onboard RISC processor running at 400 MHz. Two ports of each node are connected to a circular LEMO connector and include active transformer coupling

The FireSpy385x is equipped with 1 GByte memory and extensive hardware filtering and trigger capabilities. On the host you can control the FireSpy using a graphical user interface to analyze and display the bus traffic in a user-friendly way, or you can use the API and program your own control software.

The seamless integration of the SAE AS5643 protocol makes the FireSpy385x the preferred tool for many Aerospace & Defense development tasks. DapTechnology has taken considerable efforts to fully support the SAE AS5643 protocol in all major functional areas of the FireSpy385x and continuously updates the analyzer functionality according to implementation requirements and ongoing standardization efforts.

### 2.2.3.1. Main Feature Summary

#### General

- IEEE 1394-1995, 1394a-2000 and 1394b-2002 compliant
- Supports 200(B) , 400(B) and 800(B) Mbps transfer rates
- PCI 2.1 compliant
- 992 MByte memory for packet and data storage
- Firmware field upgradeable to enable future expansions
- AUX connector for:
  - Trigger input and output functions
  - Recording external event
- Software runs on Windows™ XP and Windows™ 7

#### Monitor

- Displays bus activity:
  - isochronous packets
  - all types of asynchronous packets
  - all types of PHY packets
  - all types of acknowledge packets
  - several types of Errors
- Counts packets according to type, speed, ack and error condition
- Counts number of bus resets
- Measurement of bus power voltages (bilingual ports)

#### Recorder

- Time stamping of all packets and status events with 10ns resolution
- Packets hidden by slower connections are visible as 'prefix only' packets
- Extensive packet/event filtering/trigger/search capabilities
  - Packet type
  - Transmission speed
  - Boolean combination of 4 programmable packet sets
  - Data payload patterns

- Error conditions
- Various status events
- Graphical Trigger Sequencer
- Adjustable trigger position within programmable record buffer size
- Cyclic pre-trigger buffer management option
- Different kinds of packet display views, including:
  - Time View, displays all packets on a time line, including the prefix
  - Packet View, displays packets as list plus selected packet options
  - Transaction View, displays transactions as list or flow graph
  - Topology View, graphical topology displays as is during recording
  - Protocol View, displays packets decoded to selected protocol
- Precise time measurements
- Marking of individual packets or packet ranges
- Export format for re-generation of packets by Scriptor or API

### **Generator**

- Simultaneous generation of up to 63 iso streams
  - Graphically programming of stream transmit block
  - Data payload import from file
- Generator and Scriptor run simultaneous for stream and asynchronous packet generation
- Special AS5643 stream generator package (optional)

### **Scriptor**

- Script Editor
  - C-like scripting language
  - Function Library
  - Macros to automatically generate blocks of code
  - Syntax coloring
  - Integrated Debugger
  - Floating point data types
- Data Editor
- Control Panel
  - Graphical display elements for data value representation
  - Ethernet-connected Client Panels for remote data monitoring
- Several Sample Scripts

### **Commander**

- Reading and/or writing of local and reading of remote PHY registers
- Reading and/or writing of remote memory locations (incl. CSR register space)
- Possibility to graphically view the current Topologies
- Sending of user definable packets

### 2.2.3.2. Specifications

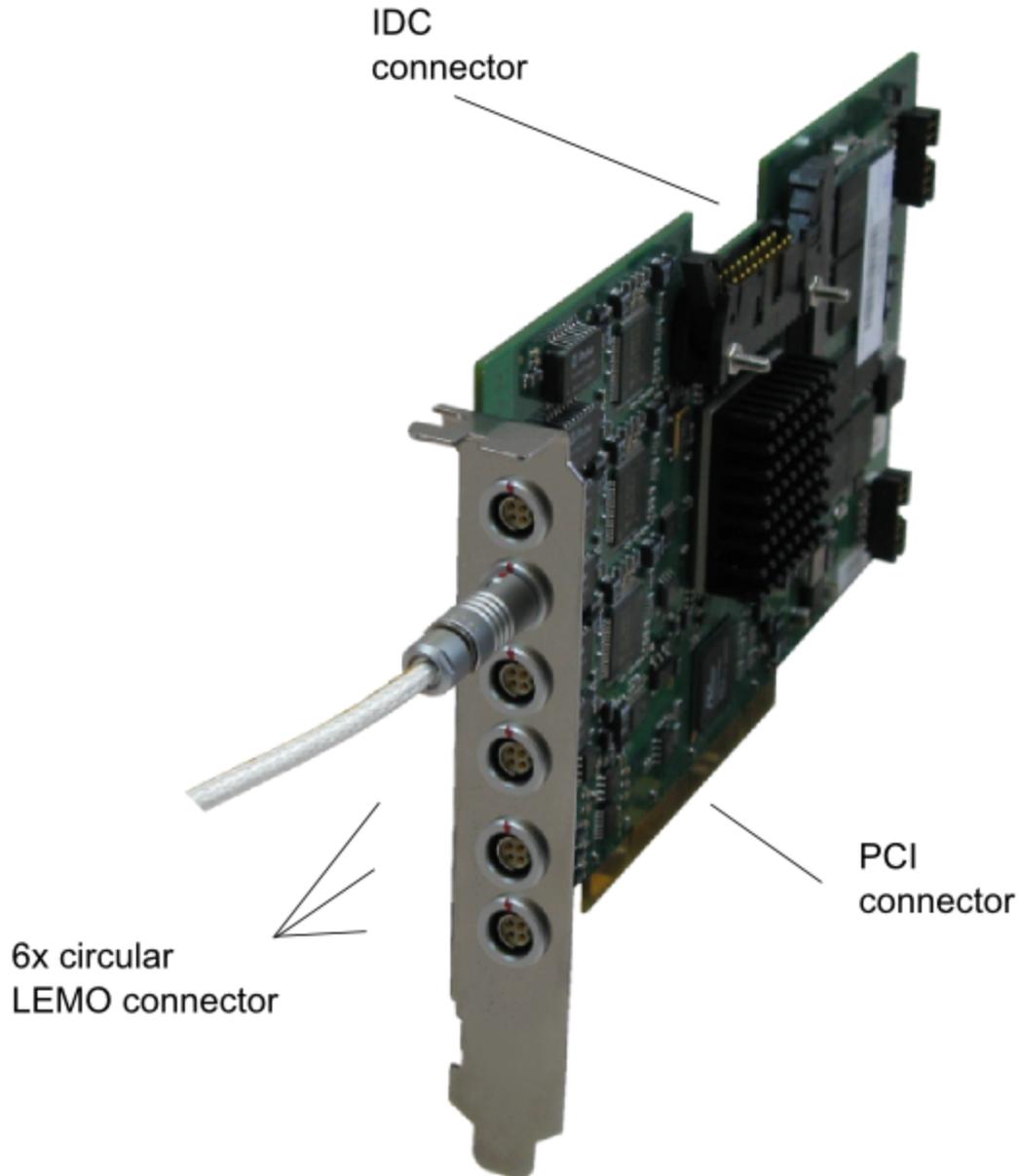
<b>Dimensions:</b>	Half Length PCI, 125 mm x 48 mm x 209 mm
<b>Weight:</b>	150 g
<b>Operating Range:</b>	0 – 70 C
<b>Power Requirements:</b>	12 V, 10 Watt maximum (without providing 1394 bus power)
<b>Compliance:</b>	FCC Class A
<b>Connections:</b>	<ul style="list-style-type: none"><li>• 32bit/33MHz PCI connector, universal keyed (for 3.3V and 5V slots)</li><li>• 6x Circular LEMO connector type FGG.0B.304.CLAD42</li></ul>
<b>Indicators:</b>	-
<b>Switches:</b>	-
<b>Package Content:</b>	<ul style="list-style-type: none"><li>• FireSpy</li><li>• 6x LEMO circular to IEEE-1394 bilingual</li></ul>
<b>Product warranty:</b>	24 months limited warranty
<b>Part Number:</b>	FS3852 or FS3852AS5643 (w. AS5643 SW protocol package)
<b>SW Add-on modules:</b>	SBP2 protocol software package IIDC protocol software package AV/C protocol software package IP1394 protocol software package AS5643 protocol software package

#### FCC Class A Compliance

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Modifications not expressly approved by the manufacturer could void the user's authority to operate the equipment under FCC rules.

### 2.2.3.3. The FS3852 PCI board



This FireSpy is a PCI card. It must be build into a PC.

#### **IDC connector**

The IDC connector is an auxiliary port. The auxiliary port will be discussed in a separate chapter. See [Auxiliary connector ports](#).

#### **Circular LEMO connector (6x)**

With these connectors the FireSpy 3852 can be connected to the IEEE1394 bus to be analyzed. Each FireSpy node (A, B, C) exposes two of its PHY ports through one LEMO connector per port. The FireSpy ports exposed are numbered top-down as follows: A0, A1, B0, B1, C0, C1. The exact connector model used is LEMO EGG.0B.304.CLL.

#### **PCI connector**

The PCI connector is the connection between this FireSpy and the computer it is to work with. Place the connector into an empty PCI slot in the computer.

## 2.2.4. FireSpy 3470

### 2.2.4.1. Main Feature Summary

#### General

- IEEE 1394-19000595, 1394a-2000 and 1394b-2002 compliant
- Supports 400(B) Mbps transfer rates
- Compact PCI PICMG 2.0 R3.0 compliant
- PXI 2.2 compliant\*
- 992 MByte memory for packet and data storage
- Firmware field upgradeable to enable future expansions
- Software runs on Windows™ XP and Windows™ 7

#### Monitor

- Displays bus activity:
  - isochronous packets
  - all types of asynchronous packets
  - all types of PHY packets
  - all types of acknowledge packets
  - several types of Errors
- Counts packets according to type, speed, ack and error condition
- Counts number of bus resets

#### Recorder

- Time stamping of all packets and status events with 10ns resolution
- Packets hidden by slower connections are visible as 'prefix only' packets
- Extensive packet/event filtering/trigger/search capabilities
  - Packet type
  - Transmission speed
  - Boolean combination of 4 programmable packet sets
  - Data payload patterns
  - Error conditions
  - Various status events
  - Graphical Trigger Sequencer
- Adjustable trigger position within programmable record buffer size
- Cyclic pre-trigger buffer management option
- Different kinds of packet display views, including:
  - Time View, displays all packets on a time line, including the prefix
  - Packet View, displays packets as list plus selected packet options
  - Transaction View, displays transactions as list or flow graph
  - Topology View, graphical topology displays as is during recording
  - Protocol View, displays packets decoded to selected protocol
- Precise time measurements
- Marking of individual packets or packet ranges
- Export format for re-generation of packets by Scriptor or API

#### Generator

- Simultaneous generation of up to 63 iso streams
  - Graphically programming of stream transmit block
  - Data payload import from file
- Generator and Scriptor run simultaneous for stream and asynchronous packet generation
- Special AS5643 stream generator package (optional)

#### Scriptor

- Script Editor
  - C-like scripting language
  - Function Library
  - Macros to automatically generate blocks of code
  - Syntax coloring
  - Integrated Debugger
  - Floating point data types
- Data Editor
- Control Panel
  - Graphical display elements for data value representation
  - Ethernet-connected Client Panels for remote data monitoring
- Several Sample Scripts

### Commander

- Reading and/or writing of local and reading of remote PHY registers
- Reading and/or writing of remote memory locations (incl. CSR register space)
- Possibility to graphically view the current Topologies
- Sending of user definable packets

\*remark, the PXI trigger bus is not used.

### 2.2.4.2. Specifications

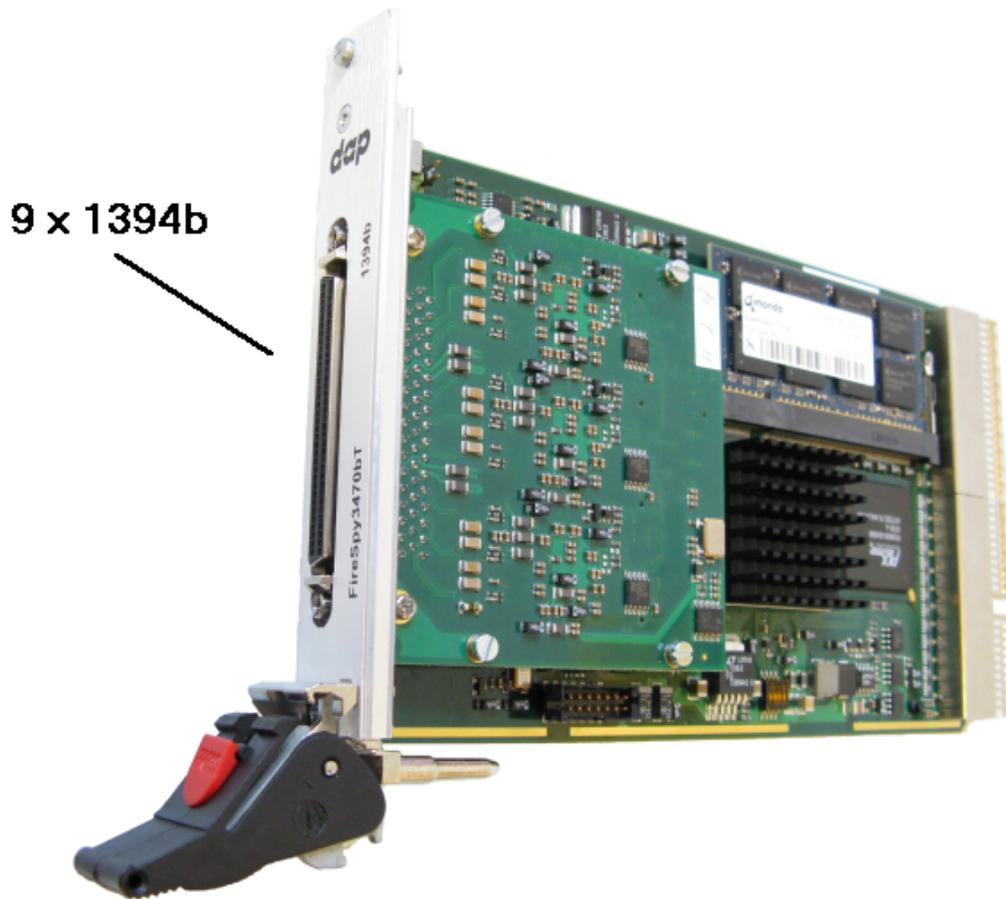
<b>Dimensions:</b>	213 mm x 130 mm x 20 mm
<b>Weight:</b>	250 g
<b>Operating Range:</b>	0 – 70 C
<b>Power Requirements:</b>	10 Watt maximum
<b>Compliance:</b>	FCC Class A
<b>Connections:</b>	<ul style="list-style-type: none"> <li>• PXI J1, J2 connector</li> <li>• 68 pins SCSI II/III Connector for 9 transformer coupled 1394Beta connections</li> </ul>
<b>Indicators:</b>	-
<b>Switches:</b>	-
<b>Package Content:</b>	FireSpy3470 Adapter Cable (SCSI2 – 1394Beta (x9))
<b>Product warranty:</b>	24 months limited warranty
<b>SW Add-on modules:</b>	SBP2 protocol software package IIDC protocol software package AV/C protocol software package IP1394 protocol software package AS5643 protocol software package

### FCC Class A Compliance

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Modifications not expressly approved by the manufacturer could void the user's authority to operate the equipment under FCC rules.

### 2.2.4.3. The PXI Board



This FireSpy is a CompactPCI / PXI card, it must be fitted in a CompactPCI / PXI chassis.

#### SCSI2 Connector

This connector is a 68 pins connector. It encompasses the transformer coupled IEEE1394b ports A0, A1, A2, B0, B1, B2, C0, C1 and C2

#### Compact PCI connector

The PCI connector is the connection between this FireSpy and the computer it is to work with. Place the connector into an empty CompactPCI slot in the computer/ PXI chassis.

## 2.3. Auxiliary connector ports

All FireSpy devices have one or more auxiliary connector ports.

The signals on these ports are:

- A number of aux signals
- Ground (for aux signals and Power if available)
- Power (not on IDC connector)

The aux signals are all open drain CMOS output with a pullup resistor to 3.3 Volts. To prevent a short it is best to only pull these signals low and allowing the internal (or an extra external pullup) resistor to pull the signal high.

When you are sure some aux signal is only used as input, it may be pulled high actively, but it may never be pulled higher than 3.7 Volts.

The current that may flow into an aux pin when driven low by the FireSpy is maximum 12 mA.

All aux signals can be controlled by the Scriptor and for some of the aux signals special functions can be

selected.

See the description of the 'External Ports' tab of the 'Settings Dialog' for the possible functions.

The Voltage of the Power signal and the current that can be drawn from it is FireSpy type dependant. The table below shows the Voltage and the maximum current that can be drawn from the Power pin.

FireSpy type	Voltage	Max current all ports together
FireSpy400b	5 +- 10%	100mA (SUBD port)
FireSpy800	5 +- 10%	100mA (SUBD port)
FireSpy410b	12 +- 10%	100mA (SUBD port)
FireSpy810	12 +- 10%	100mA (SUBD port)
FireSpy381x	12 +- 10%	200mA (SUBD and VHDCI ports together)
FireSpy385x	12 +- 10%	200mA (VHDCI port)

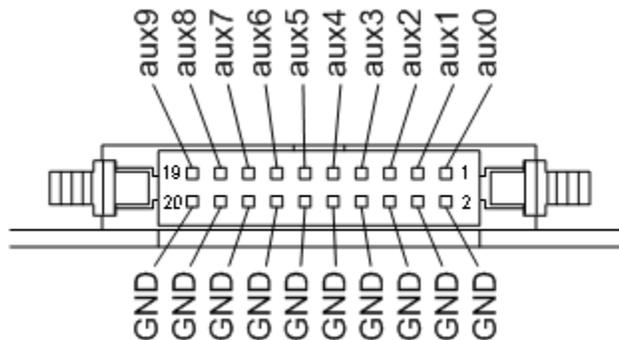
Note that the Power on the VHDCI connector can be switched off. See the General tab of the Settings Dialog.

Each aux port can be configured to have an active /TriggerOut pin. (This can be configured in the settingsdialog.) When the recorder is triggered, this pin will be active low for a duration of about 160nS.

### 2.3.1. The IDC connector

The 20 pin IDC connector is available for the FireSpy PCI cards.

It has 10 aux signals.



This 20 pins connector has the following signals:

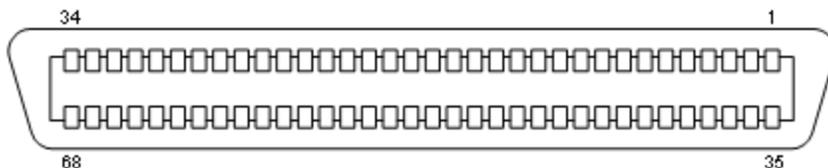
Pin 1	aux0
Pin 2	Ground
Pin 3	aux1
Pin 4	Ground
Pin 5	aux2
Pin 6	Ground
Pin 7	aux3
Pin 8	Ground
Pin 9	aux4
Pin 10	Ground
Pin 11	aux5
Pin 12	Ground
Pin 13	aux6
Pin 14	Ground
Pin 15	aux7
Pin 16	Ground
Pin 17	aux8
Pin 18	Ground
Pin 19	aux9
Pin 20	Ground

For a description of the aux signals, [see above](#).

## 2.3.2. The VHDCI Connector

The VHDCI connector is available for the FireSpy Triple Series.

This connector has 6 transformer coupled IEEE1394b ports. Two for each node in the FireSpy. These Ports are A0 and A1 for the first node, B0 and B1 for the second node and C0 and C1 for the third node. This connector also holds 6 aux signals and optional power. Note that the power can be switched on and off using the Settings Dialog.



VHDCI Pins	Name	Port
Pin 1	Not used	
Pin 2	Cable shield	
Pin 3	C1-TPA+	Port C1
Pin 4	Not used	
Pin 5	C1-TPB+	Port C1
Pin 6	Cable shield	
Pin 7	C0-TPA+	Port C0
Pin 8	Not used	
Pin 9	C0-TPB+	Port C0
Pin 10	Cable shield	
Pin 11	B1-TPA+	Port B1
Pin 12	Not used	
Pin 13	B1-TPB+	Port B1
Pin 14	Cable shield	
Pin 15	Ground	CONTROL
Pin 16	Ground	CONTROL
Pin 17	Aux4	CONTROL
Pin 18	Aux2	CONTROL
Pin 19	Aux0	CONTROL
Pin 20	Cable shield	
Pin 21	Power	CONTROL
Pin 22	Cable shield	
Pin 23	B0-TPA+	Port B0
Pin 24	Not used	
Pin 25	B0-TPB+	Port B0
Pin 26	Cable shield	
Pin 27	A1-TPA+	Port A1
Pin 28	Not used	
Pin 29	A1-TPB+	Port A1
Pin 30	Cable shield	
Pin 31	A0-TPA+	Port A0
Pin 32	Not used	
Pin 33	A0-TPB+	Port A0
Pin 34	Cable shield	
Pin 35	Not used	
Pin 36	Cable shield	
Pin 37	C1-TPA-	Port C1
Pin 38	Not used	
Pin 39	C1-TPB-	Port C1
Pin 40	Cable shield	
Pin 41	C0-TPA-	Port C0

Pin 42	Not used	
Pin 43	C0-TPB-	Port C0
Pin 44	Cable shield	
Pin 45	B1-TPA-	Port B1
Pin 46	Not used	
Pin 47	B1-TPB-	Port B1
Pin 48	Cable shield	
Pin 49	Ground	
Pin 50	Ground	
Pin 51	Aux5	CONTROL
Pin 52	Aux3	CONTROL
Pin 53	Aux1	CONTROL
Pin 54	Cable shield	
Pin 55	Power	
Pin 56	Cable shield	
Pin 57	B0-TPA-	Port B0
Pin 58	Not used	
Pin 59	B0-TPB-	Port B0
Pin 60	Cable shield	
Pin 61	A1-TPA-	Port A1
Pin 62	Not used	
Pin 63	A1-TPB-	Port A1
Pin 64	Cable shield	
Pin 65	A0-TPA-	Port A0
Pin 66	Not used	
Pin 67	A0-TPB-	Port A0
Pin 68	Cable shield	

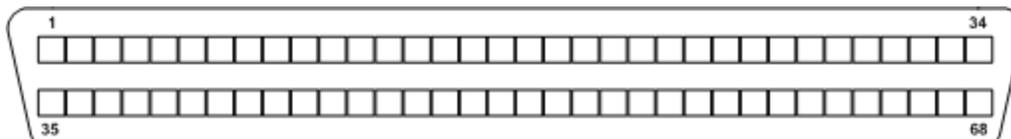
Note that the metal parts of the connector are connected to 'Cable shield'.

For a description of the aux signals and the Power signal, [see above](#).

### 2.3.3. The SCSI2 Connector

The SCSI2 connector is available for the FireSpy 3470

This connector has 9 transformer coupled IEEE1394b ports. Three for each node in the FireSpy. These Ports are A0, A1 and A2 for the first node, B0, B1 and B2 for the second node and C0, C1 and C2 for the third node.



SCSI2 Pins	Name	Port
Pin 1	Cable shield	
Pin 2	TPA+	Port A2
Pin 3	TPA-	Port A2
Pin 4	Cable shield	
Pin 5	TPA+	Port A1
Pin 6	TPA-	Port A1
Pin 7	Cable shield	
Pin 8	TPA+	Port A0
Pin 9	TPA-	Port A0
Pin 10	Cable shield	
Pin 11	VCC12	
Pin 12	VCC12	
Pin 13	Cable shield	

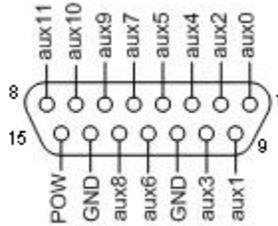
Pin 14	TPA+	Port B2
Pin 15	TPA-	Port B2
Pin 16	Cable shield	
Pin 17	TPA+	Port B1
Pin 18	TPA-	Port B1
Pin 19	Cable shield	
Pin 20	TPA+	Port B0
Pin 21	TPA-	Port B0
Pin 22	Cable shield	
Pin 23	VCC12	
Pin 24	VCC12	
Pin 25	Cable shield	
Pin 26	TPA+	Port C2
Pin 27	TPA-	Port C2
Pin 28	Cable shield	
Pin 29	TPA+	Port C1
Pin 30	TPA-	Port C1
Pin 31	Cable shield	
Pin 32	TPA+	Port C0
Pin 33	TPA-	Port C0
Pin 34	Cable shield	
Pin 35	Cable shield	
Pin 36	TPB+	Port A2
Pin 37	TPB-	Port A2
Pin 38	Cable shield	
Pin 39	TPB+	Port A1
Pin 40	TPB-	Port A1
Pin 41	Cable shield	
Pin 42	TPB+	Port A0
Pin 43	TPB-	Port A0
Pin 44	Cable shield	
Pin 45	Ground	
Pin 46	Ground	
Pin 47	Cable shield	
Pin 48	TPB+	Port B2
Pin 49	TPB-	Port B2
Pin 50	Cable shield	
Pin 51	TPB+	Port B1
Pin 52	TPB-	Port B1
Pin 53	Cable shield	
Pin 54	TPB+	Port B0
Pin 55	TPB-	Port B0
Pin 56	Cable shield	
Pin 57	Ground	
Pin 58	Ground	
Pin 59	Cable shield	
Pin 60	TPB+	Port C2
Pin 61	TPB-	Port C2
Pin 62	Cable shield	
Pin 63	TPB+	Port C1
Pin 64	TPB-	Port C1
Pin 65	Cable shield	
Pin 66	TPB+	Port C0
Pin 67	TPB-	Port C0
Pin 68	Cable shield	

Note that the metal parts of the connector are connected to 'Cable shield'.

### 2.3.4. The SUBD connector

The 15 pin SUBD connector is available for the external FireSpy units.

It has 12 aux signals and power.



This 15 pin SUBD connector has the following signals:

Pin	Name (Basic & Advanced)	Name (Gen 4)
1	aux0	aux0
2	aux2	aux2
3	aux4	aux4 (IRIG1)
4	aux5	aux5 (IRIG2)
5	aux7	aux7 (TIM2)
6	aux9	RS232 Receive
7	aux10	aux10 (VS-Sync)
8	aux11	RS232 Transmit
9	aux1	aux1
10	aux3	aux3 (TIM1)
11	Ground	Ground
12	aux6	aux6 (IRIG3)
13	aux8	aux8 (TIM3)
14	Ground	Ground
15	Power	Power

For a description of the aux signals and the Power signal, [see above](#).

## Chapter 3. Installation

DapTechnology analyzers are not packaged with any software-installation media. This is because we would like our customers to use the very latest software available and not an old version that happened to be the latest when we packaged the product.

You will be able to download the latest software version from our website: <http://www.daptechnology.com>

Click on the support button at the top of the web page and after inserting the serial number of your FireSpy, which can be found at the back of the unit, you will get access to your custom download page. On this page you will find the license keys for your analyzer as well as links to the software downloads available for your analyzer. (latest recommended or latest beta version)

### 3.1. Windows

#### 3.1.1. Installing the Software

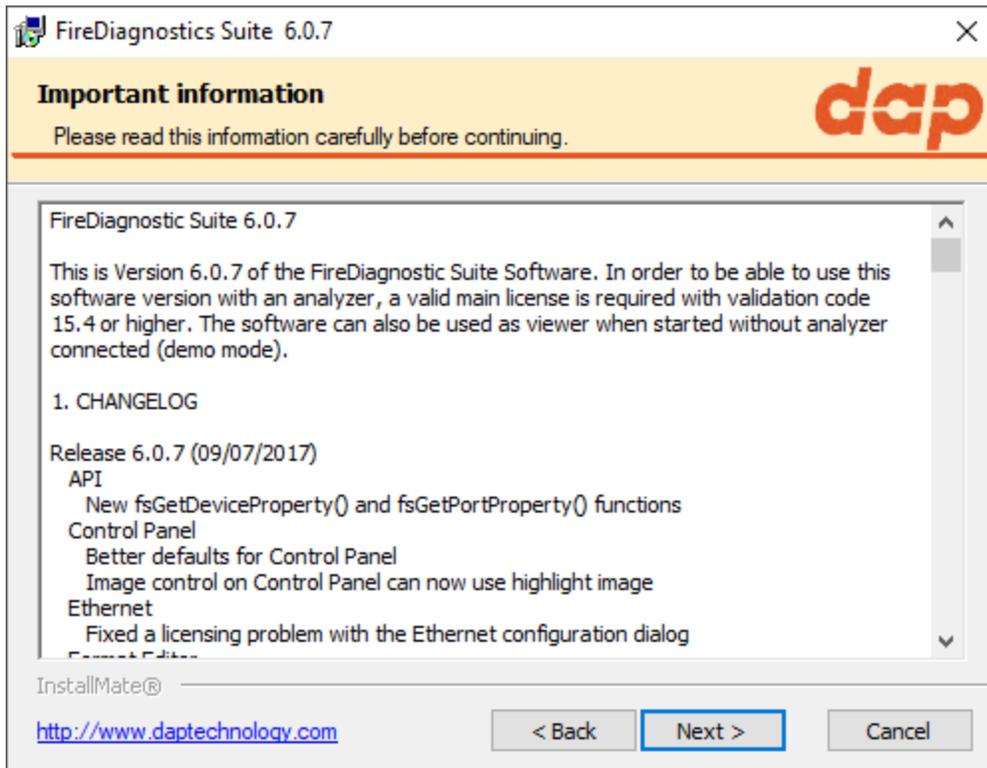
After downloading the FireDiagnostics Suite version of your choice from DapTechnology's website, please open the compressed folder and locate the file setup.exe. Run the setup.exe file, by one of the following ways:

- double click on the setup.exe file
- select 'Start->Run', browse to the setup.exe file and click 'OK'
- click with the right mouse button on setup.exe and select 'Open'

After starting the setup.exe program, the following window will be displayed. Note that the software version could be different if you are installing another version of the software.



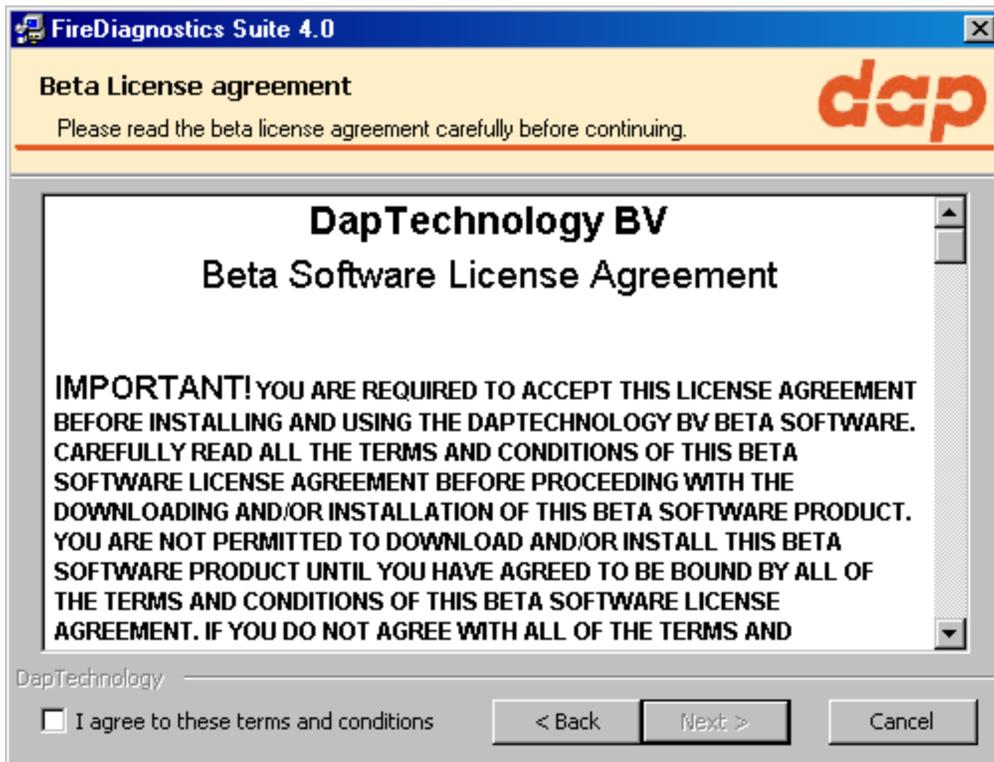
After clicking on "Next", the following window will be showed. It contains the latest information about the version of the software you are about to install. Please read it carefully before proceeding to the next step. The picture below contains just some example information.



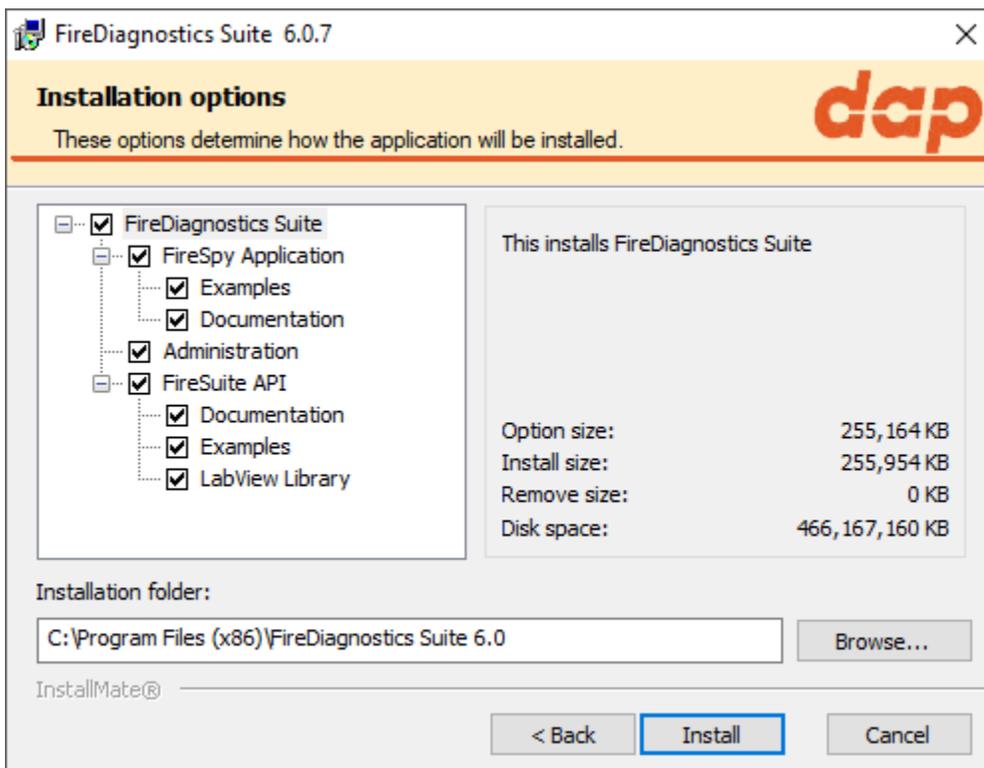
After clicking on "Next", the following window will be showed. It contains the License Information for the software you are about to install. Please read it carefully and check the checkbox to agree to the license agreement before proceeding to the next step.



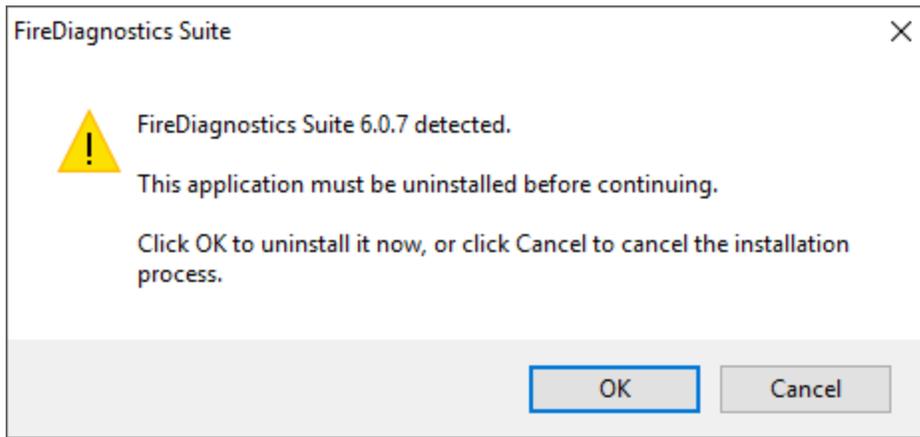
If you are installing a beta software version, an additional license agreement needs to be agreed with before continuing the installation process. Please check the checkbox and click next.



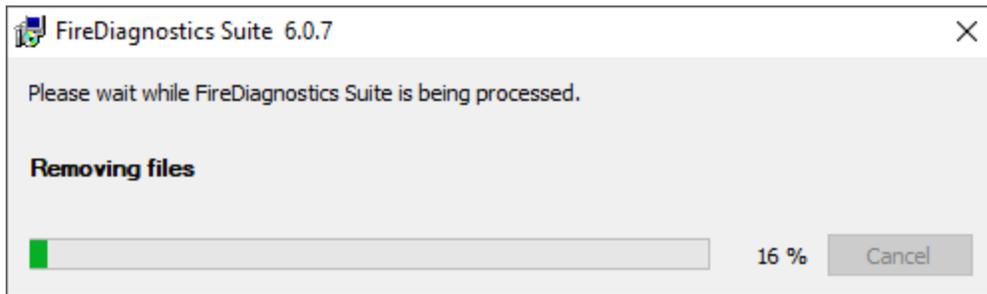
The installer options dialog as shown below allows the user to select which components to install. We recommend installing all components, however it is also possible to leave some components out.



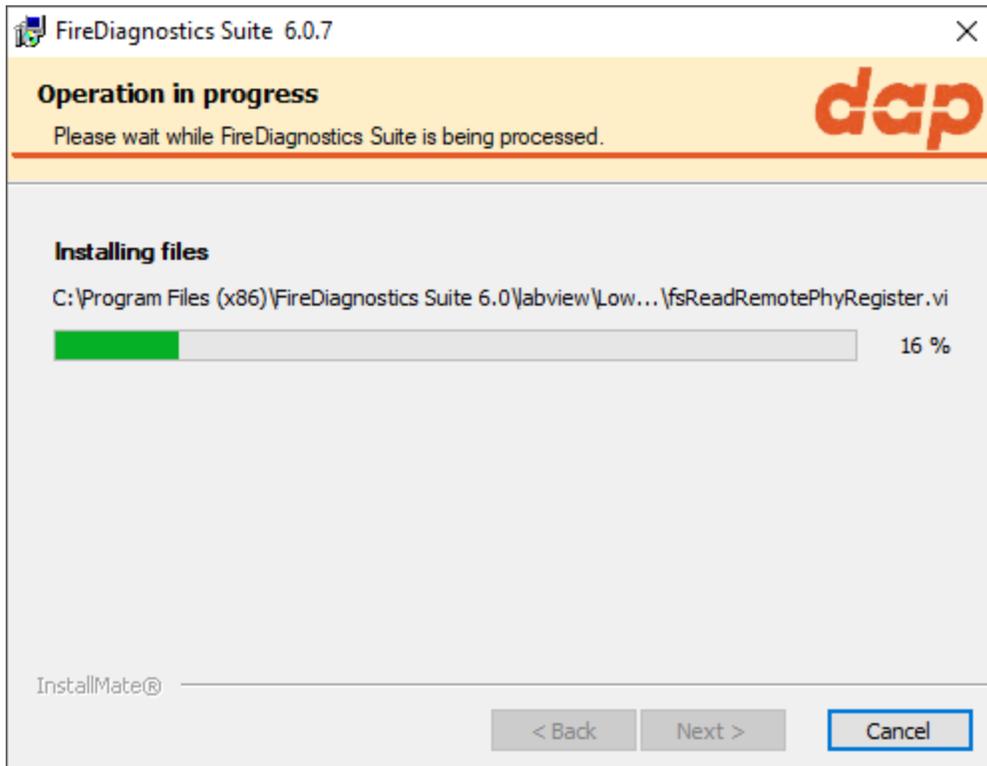
If another FireDiagnostics Suite installed version with the same main version number is found it needs to be reinstalled before the installer is able to continue. Software versions with a different major version number can be used alongside each other. Please click ok to proceed with the uninstallation process.



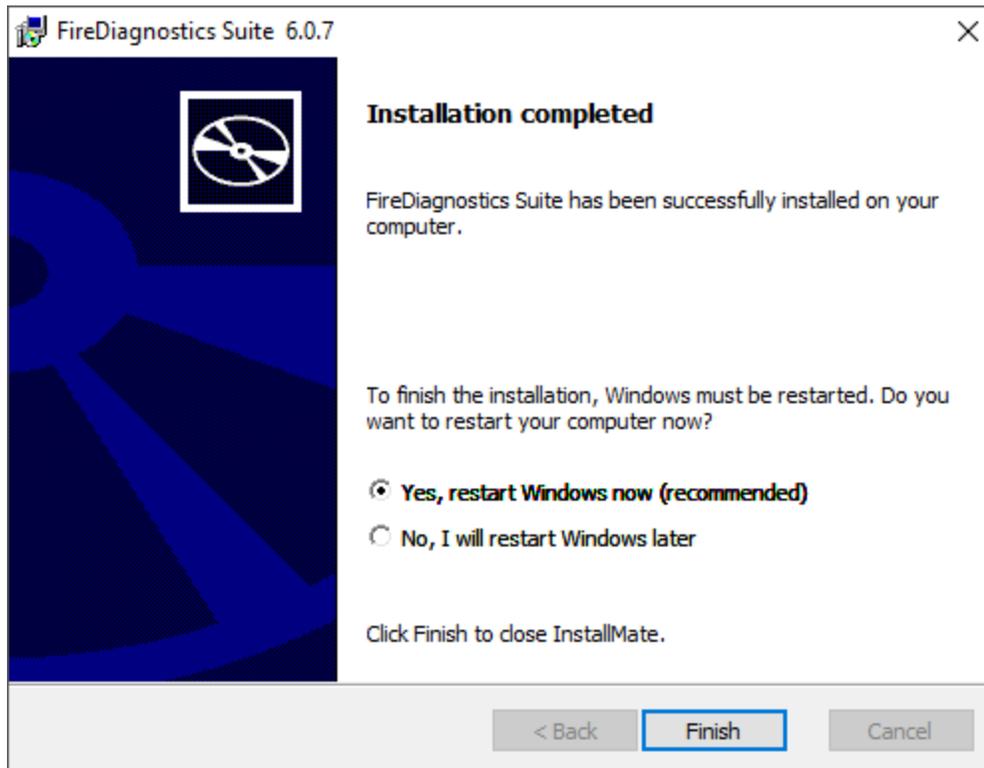
The following dialog will show uninstallation progress. Please wait until it finishes.



The following dialog will show installation progress. Please wait until it finishes.



After the installation is complete, the following dialog will appear. We recommend to always restart your computer after installing the FireDiagnostics software.



### 3.1.2. Installing the Driver

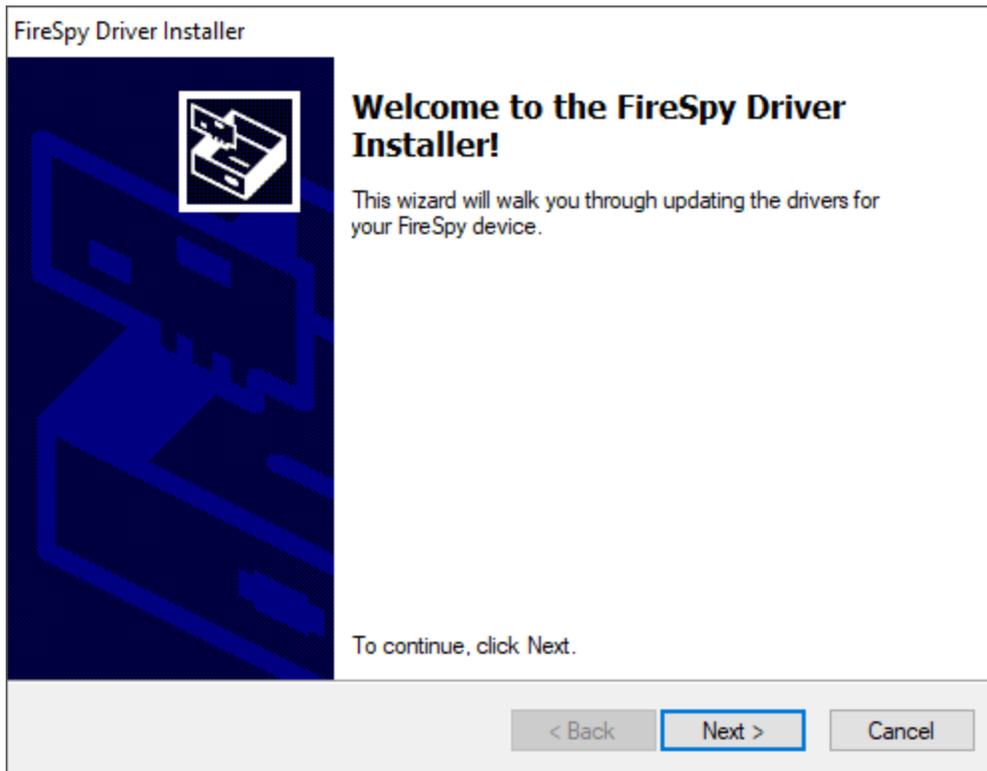
The driver installation will automatically start following the FireDiagnostics Suite installation, after the machine is rebooted. This installer will install the drivers for Windows 7 and Windows 10. Older Windows versions still work with the supplied drivers, but some additional steps may be required during installation. These steps are described in chapter [Older Windows versions](#).

After the device driver is installed the device ready to be used. Please continue reading at the "[Getting Started](#)" section.

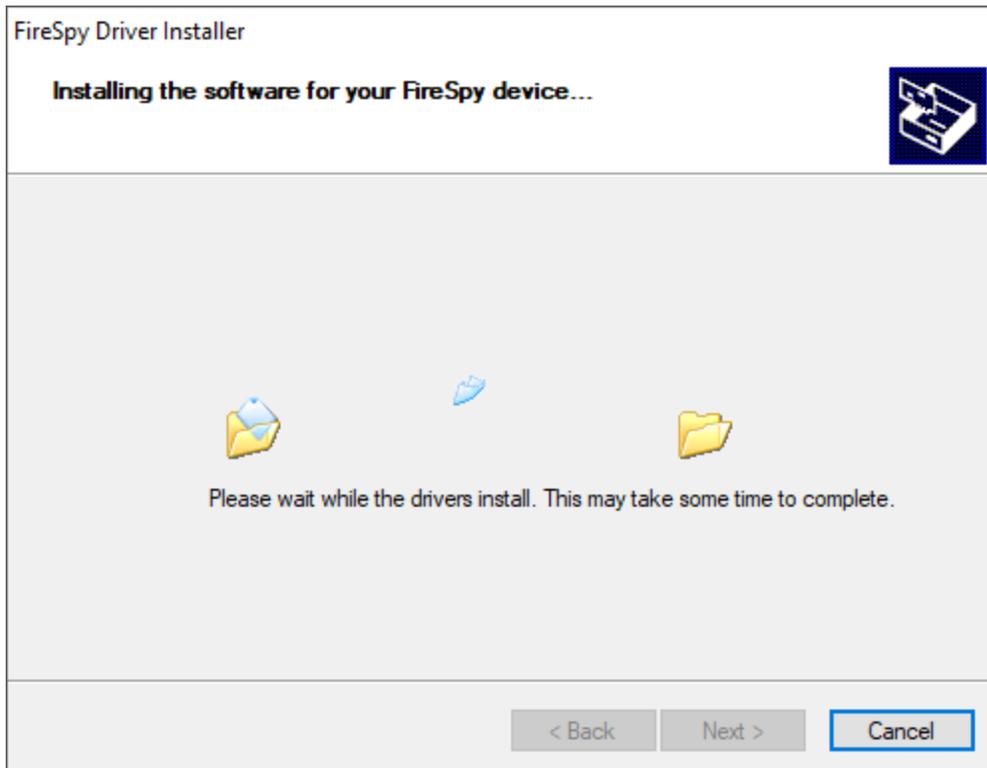
#### 3.1.2.1. Windows Driver installer

At this point it is required to reboot the machine in order to install the device drivers. The device drivers will pre-allocate some memory that can be used for performing DMA operations and this needs to be done as early as possible after system startup. If done at a later point during system run it can take a very long time to load the driver.

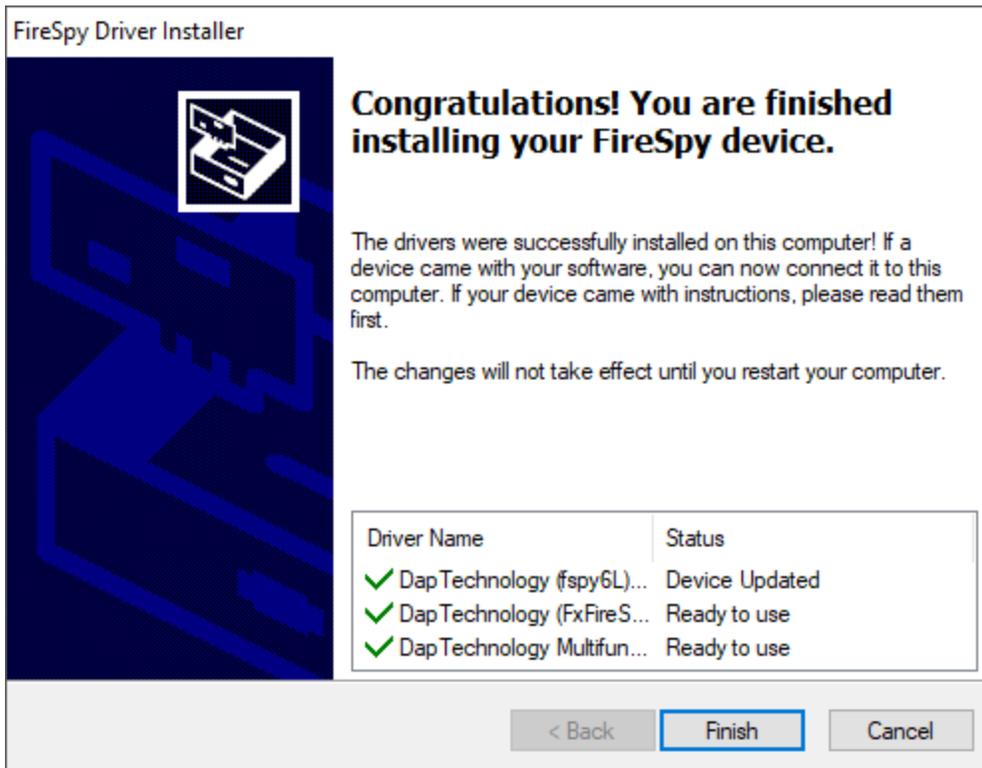
After rebooting the machine, the following window will be displayed. Note that the software version could be different if you are installing another version of the software.



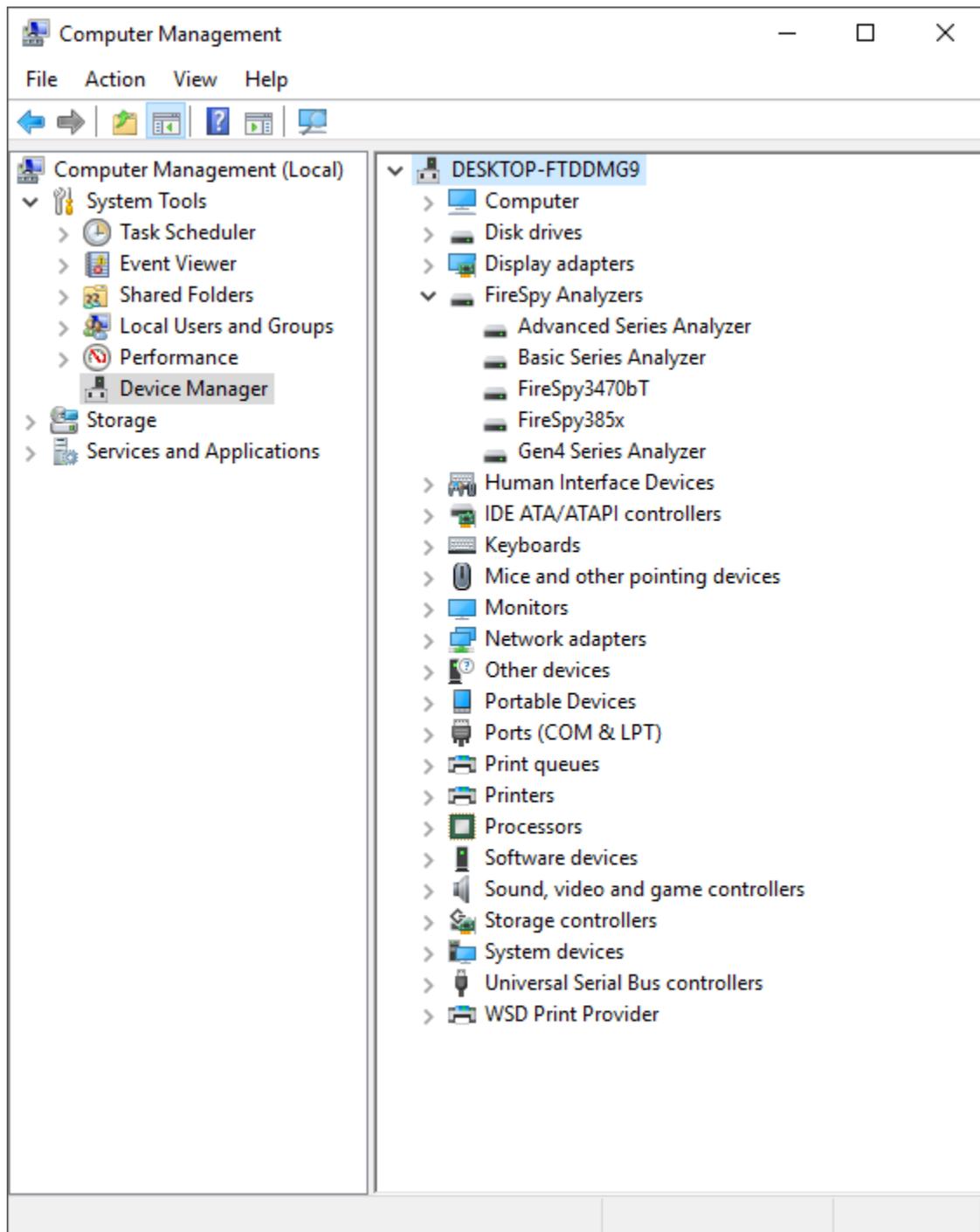
After clicking "Next", the drivers will be installed. Please wait until it finishes.



After the drivers are installed the following window will be shown. Click "Finish" to close the installation.



After you are booted to the desktop, you may check the device manager if the install has succeeded. The device manager will show a FireSpy under "Multifunction adapters". Here you find a several functions the device has.



#### 3.1.2.1.1 Older Windows versions

For Windows versions older than Windows 7 some additional steps during the Driver installation may be required.

After the FireDiagnostics Suite installation, and after rebooting the machine, the Driver installer will start. During the installation the Windows Driver Wizard may appear, as shown in the following image. Please click "Cancel" to close the wizard for now, we need to install the drivers first before Windows can search for them.



At the start of the installation the following message may be displayed, saying the software has not passed Windows Logo testing. The FireSpy Logo testing is not supported for Windows versions older than Windows 7, but function on these Windows version regardless. Click "Continue Anyway" to continue with the installation.



During the installation of the Drivers, the following message may be displayed, saying the driver certificate has expired. As with the Windows Logo testing, the FireSpy driver signing is not supported for older Windows versions. Click "Yes" to continue installing the driver. This message may appear once or more during installation, depending on the number of FireSpy devices connected to the machine.

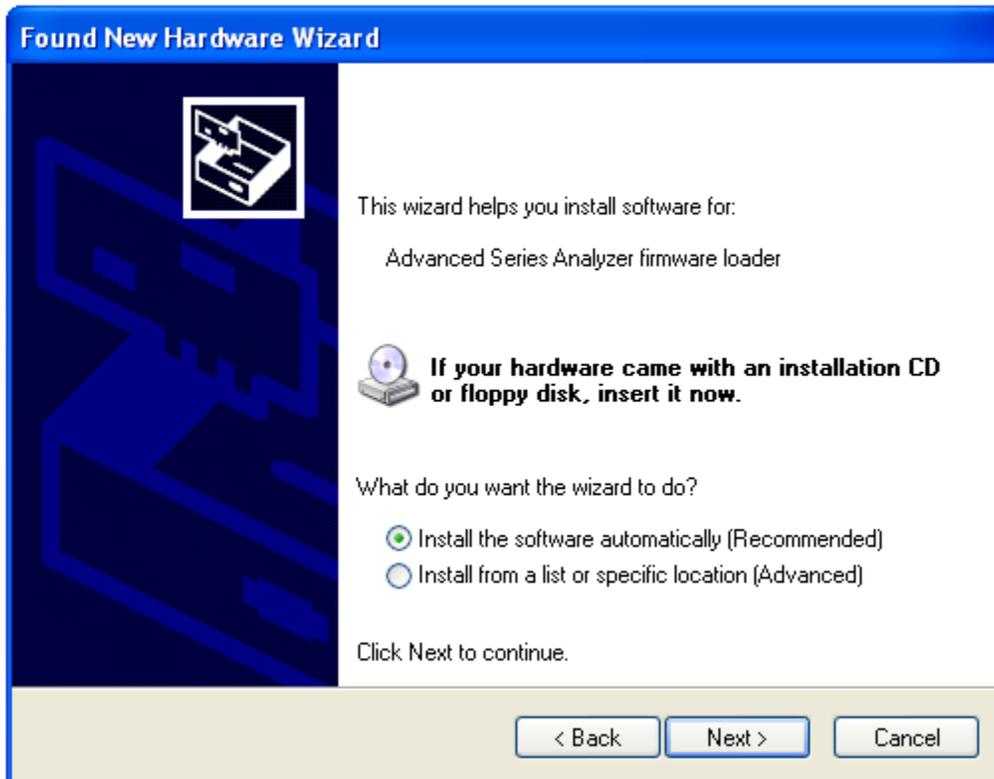


After the drivers are installed the following window will appear. Click "Finish" to continue starting Windows.

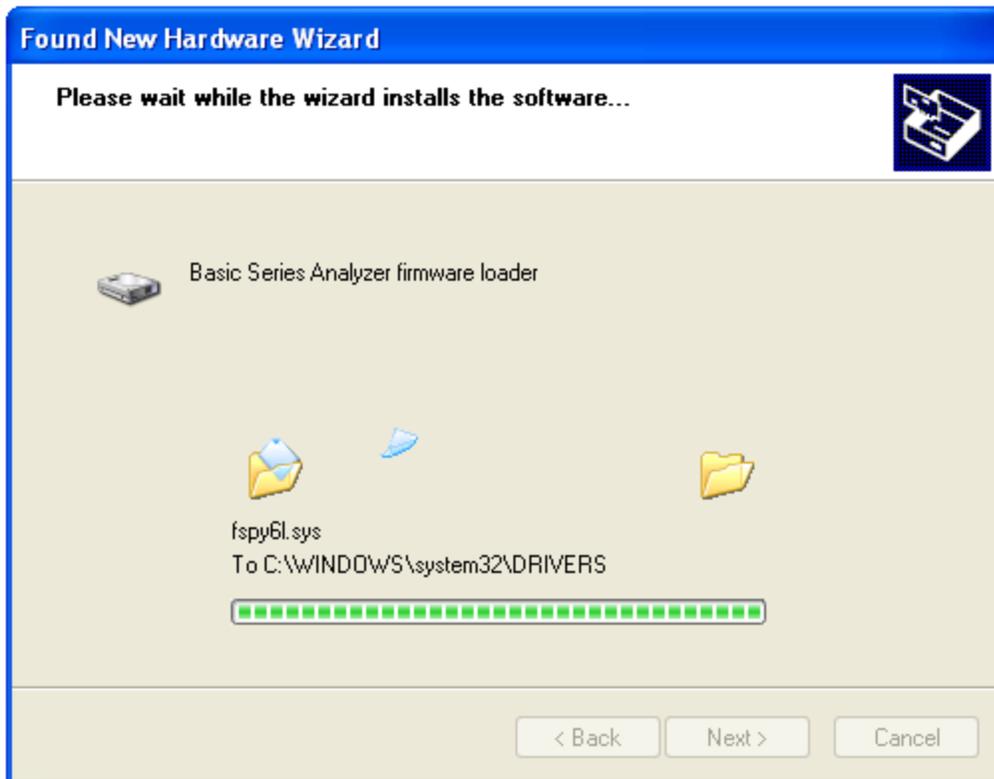


Any devices that were connected to the machine during the installation should work now. If there were any unplugged devices, please connect them to the machine now. The Windows Driver Wizard mentioned earlier should appear now. If it doesn't please reboot the machine. In the Driver Wizard, select the bottom option "No, not this time" to search for the already installed drivers, and click "Next" to continue.

Select the top option "Install the software automatically" from the following dialog, to let Windows search for the installed FireSpy drivers.



After clicking "Next" the Wizard will install the driver for the FireSpy device. Repeat this process for any additional FireSpy device that was not yet correctly installed during the installation.



### 3.1.2.2. Manual driver (un)installation

Drivers will be uninstalled when uninstalling the FireDiagnostics Suite. The uninstaller can be found in the Windows Start menu, under FireDiagnostics Suite x.x -> Uninstall FireDiagnostics Suite (for Windows 10), or FireDiagnostics Suite x.x -> Administration -> Uninstall FireDiagnostics Suite (for older Windows versions).

For example, when switching between versions of the FireDiagnostics Suite it may be needed to install a specific version of the FireSpy drivers manually without installing/uninstalling the complete FireDiagnosticsSuite software packaged, you can use the Driver Installer. This can be found in the Windows Start menu, under FireDiagnostics Suite x.x -> Install Drivers (for Windows 10) or FireDiagnostics Suite x.x -> Drivers -> Install Drivers (for older Windows versions). [A dialog will popup](#) and it will install the drivers.

### 3.1.3. Ethernet Configuration

This chapter describes the configuration steps to be taken to enable Ethernet communication with a FireSpy x810. To communicate with a FireSpy x810 it should be connected to the company LAN (Local Area Network). Until now only the speed 10Mbit/s full is supported. In the future auto-negotiation and speed 100Mbit/s will also be supported.

The EthernetConfig tool programs the flash memory inside the FireSpy with the same firmware as during the startup phase of the device. Some companies have a policy that all programmable memory must be erased before it can be shipped elsewhere. To do this the Ethernet Configuration Tool has been given an option to erase this flash memory. It can be found under: Extra -> Erase Complete Flash.

#### 3.1.3.1. Configuration steps FireSpy x810

To configure a FireSpy x810 correctly a prerequisite is that you have the following TCP/IP info:

- A free IP-address,
- the subnet mask
- and the IP-address of the default gateway.

Please, contact your system administration if you don't have this information.

Follow the steps below to configure a FireSpy x810.

#### Step 1

Connect the FireSpy x810 to a PC via USB on which the FireDiagnostics Suite software is installed. Switch on the power of the FireSpy x810.

#### Step 2

Start the application 'FireSpy Configuration Tool' which is part of the FireDiagnostics Suite Software. You can find this application via the Start menu button under menu FireDiagnostics Suite x.x.

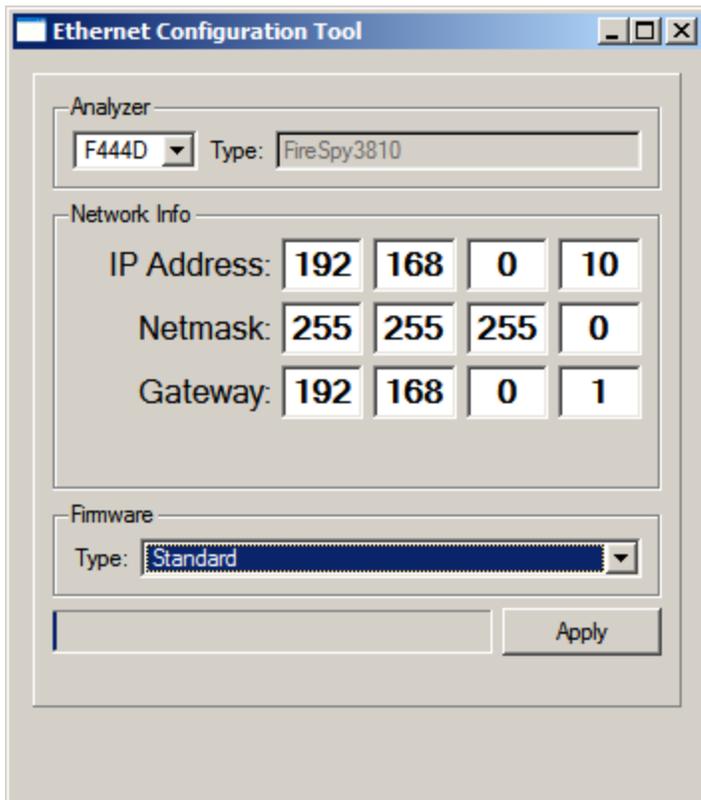
#### Step 3

Fill in the following TCP/IP info:

- the FireSpy x810 IP-address in field 'IP-address',
- the subnet mask in field 'subnet mask'
- and the IP-address of the default gateway in field 'Gateway'.

#### Step 4

Press button 'Apply'. The filled in TCP/IP info and the firmware will be written respectively to eeprom and flash of the FireSpy x810. The progress of writing firmware is shown by the progress bar, see figure below.



#### Step 5

Wait until the firmware is written. Switch off the power and disconnect USB.

Switch on the power and verify that led 'init' is on and turns off in about 8 seconds. If so the FireSpy x810 is configured successfully. Otherwise please repeat the above steps.

The FireSpy x810 is now able to start-up autonomously from flash. The written firmware to flash enables communication with the FireSpy x810 via Ethernet.

**Please, note that a FireSpy x810 will not start-up from flash when it's connected via USB.**

To communicate with the configured FireSpy x810 you should connect it to the company LAN and configure the FireSpy application to search for the configured FireSpy x810. To configure the FireSpy application, see the following chapter.

#### 3.1.3.2. Configuration steps FireSpy application

In order to communicate with a FireSpy x810 connected to the company LAN the FireSpy application must know its IP-address.

To set-up the FireSpy x810 IP-address please follow the steps below.

#### Step 1

Start the FireSpy Application. You can find this application via the Start menu button under menu FireDiagnostics Suite x.x. It will either issue a warning or show the FireSpy chooser dialog. This is not important at this time, just continue until the main screen shows up as in the picture below: (the green LED will be red in your case, indicating that no analyzer is connected)

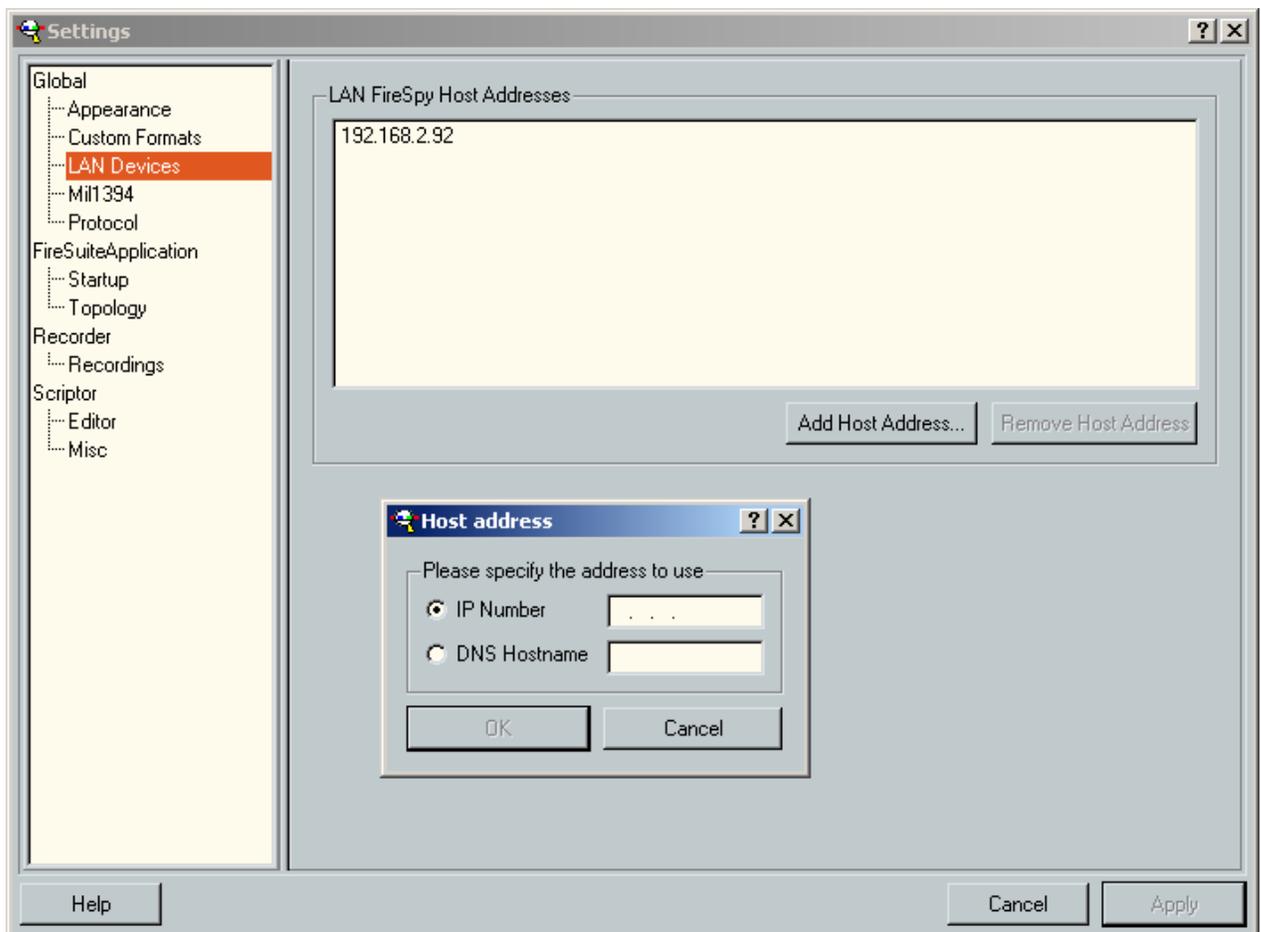


### Step 2

From the "Tools" menu open 'Settings' and click on item 'LAN Devices'.

### Step 3

See figure below. Click 'Add Host address...' and fill in either the IP number or the DNS host address that is routed to the FireSpy. Make sure the address is valid and click 'OK' when finished.



### Step 4

Now press the apply button and close the dialog.

### Step 5

Please proceed with the [Getting Started](#) section to open the newly configured device.

## Chapter 4. Getting Started

This section of the manual provides a quick-start guide for your analyzer and software. If you need help installing the application, please take a look at the [Installation](#).

### 4.1. Starting the Application

If you haven't already done so, install the software as described in [Installation](#). Make sure the devices are properly installed in or connected to the computer, have a matching power source and are turned on (where applicable). Run the FireSpy application from the Windows Start menu -> Programs -> FireDiagnostics Suite.

#### Device Selection

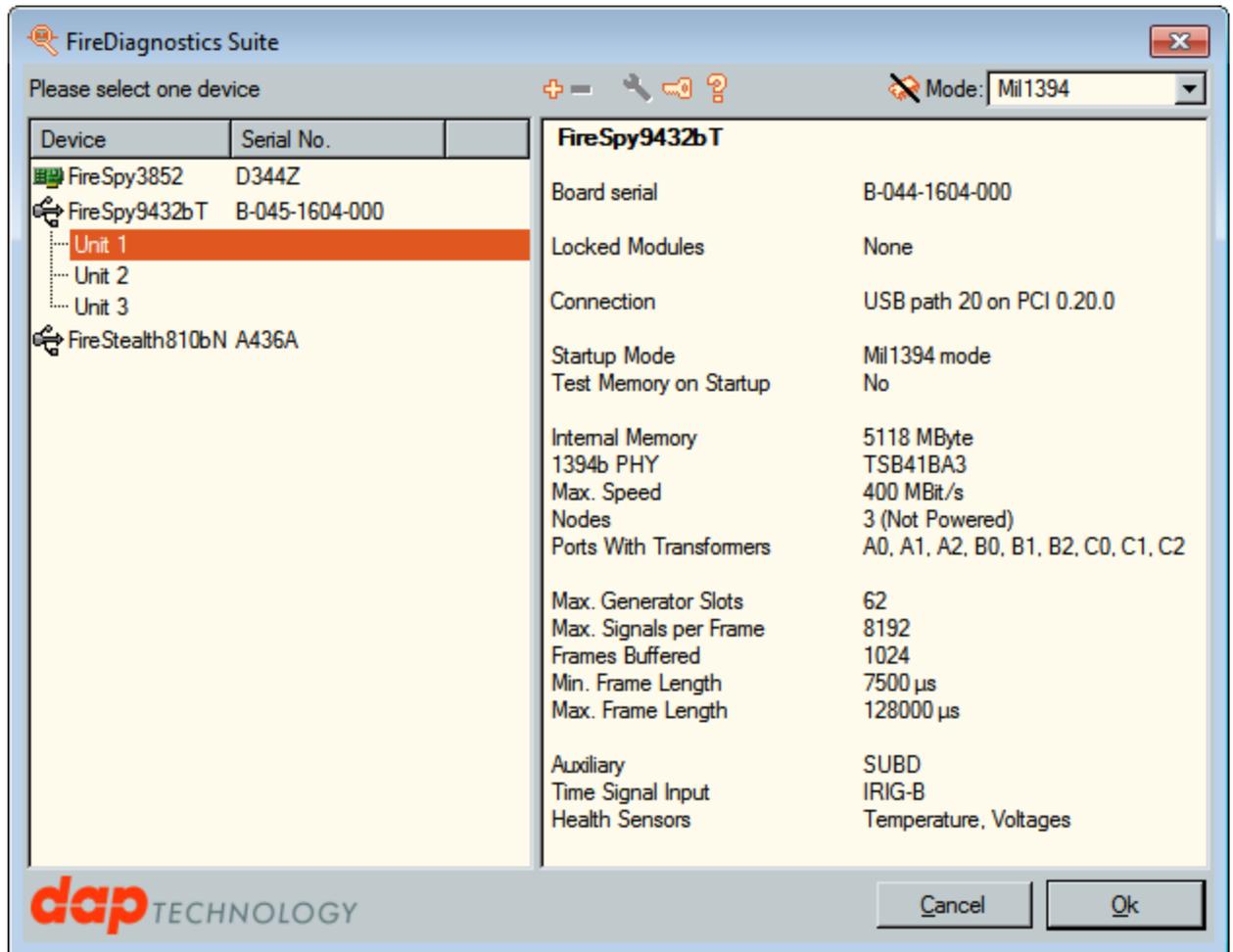
The device selection dialog will pop up, as shown in the picture below. The list on the left side shows the serial numbers of the currently connected devices, as well as their IP addresses or DNS hostnames in case they are connected by ethernet. All registered ethernet addresses are shown, including those of disconnected devices.

Plug and play devices, such as USB and ethernet devices, can be connected or disconnected without restarting the application or resetting the device. They will be automatically added or removed from the list within a few seconds. Ethernet devices first have to be configured, as explained in the next section, and their host address has to be manually added to the list.

The toolbar on the upper right side of the dialog can be used to modify the startup settings of the device. Ethernet addresses can be added or removed using the + and - buttons on the left of the toolbar. Mil1394, Normal or Symbol Recorder mode (when licensed) can be selected by expanding the Mode combo box on the right. Left of the Mode combo box, a tool button exists for enabling or disabling the memory test that is performed after the firmware is uploaded. This tool button is marked by a chip icon, and can be found next to the Mil1394 tool button.

The right side of the device selection dialog has three possible configuration modes, which are explained in further detail below. Apart from the default device information mode, the tool button with the wrench icon can be clicked to enter the ethernet configuration mode and the tool button with the key icon enters or exits the license configuration mode. Finally, the tool button with the question mark can be clicked to open the manual relevant to the current mode. In the default (device information) mode, the device manual of the selected device is opened. In the other two modes, either the ethernet configuration manual or the license configuration manual will be opened.

In some cases, for instance when starting the Monitor application directly, multiple analyzers can be selected at once. Sometimes it is also possible to start the application without selecting any devices (note that clicking on a selected item de-selects it). In that case, you can still select Mil1394 mode, for instance when you wish to use Mil1394 functionality in the Scriptor while no analyzer is available.



### No Devices Shown - IMPORTANT NOTICE

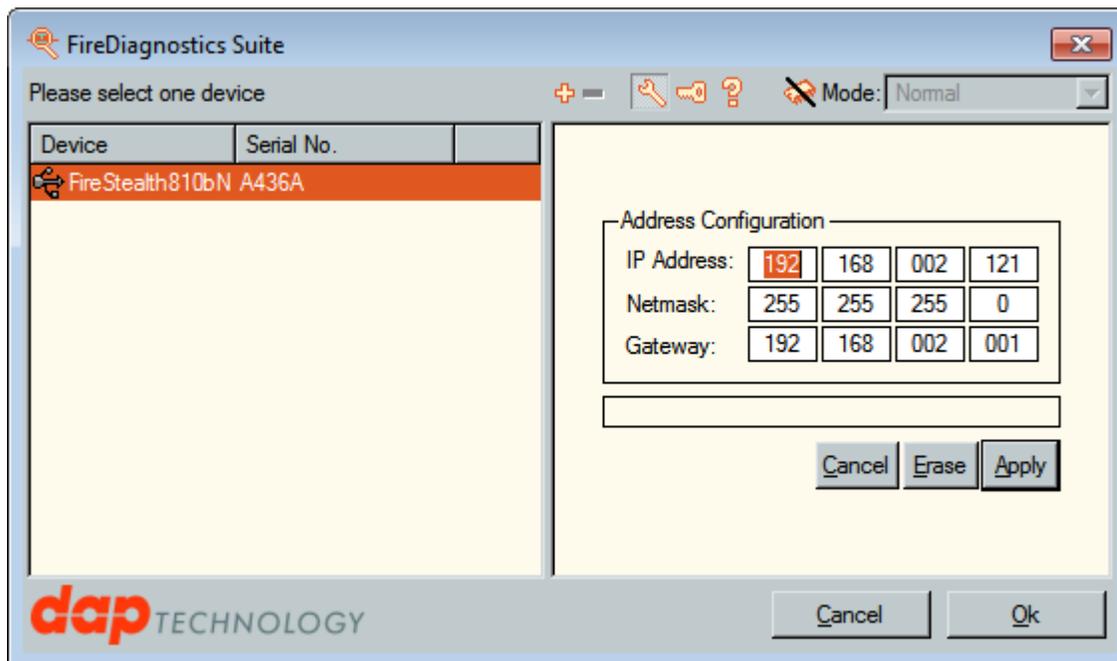
In case you are sure a FireSpy is properly connected but it is not shown in the Device Selection dialog, it may be needed to manually install the drivers. This could also be needed when multiple versions of the FireDiagnostics Suite are installed and you want to switch between them. Please refer to the section about [Manual Driver Instalation](#).

### Ethernet Configuration

Devices equipped with an ethernet connection can be configured by clicking the tool button with the wrench icon. This enters the ethernet configuration mode, as shown below. When the IP data are loaded, you can change it and press the Apply button to store the new configuration. The tool button with the aircraft icon can be used to configure the ethernet interface in Mil1394 mode or not. The Flash memory can be erased (for secure transport) by clicking the Erase button. The operation can be safely canceled by pressing the 'Cancel' button. However, the ethernet interface will not be operational until it has been fully configured.

Extra options will be shown when a standalone analyzer can enable or disable the power on specific buses on startup.

Note that a device's ethernet interface cannot be opened when it has been loaded by another version of the application. More information about the ethernet configuration can be found in the [Ethernet Configuration Manual](#).



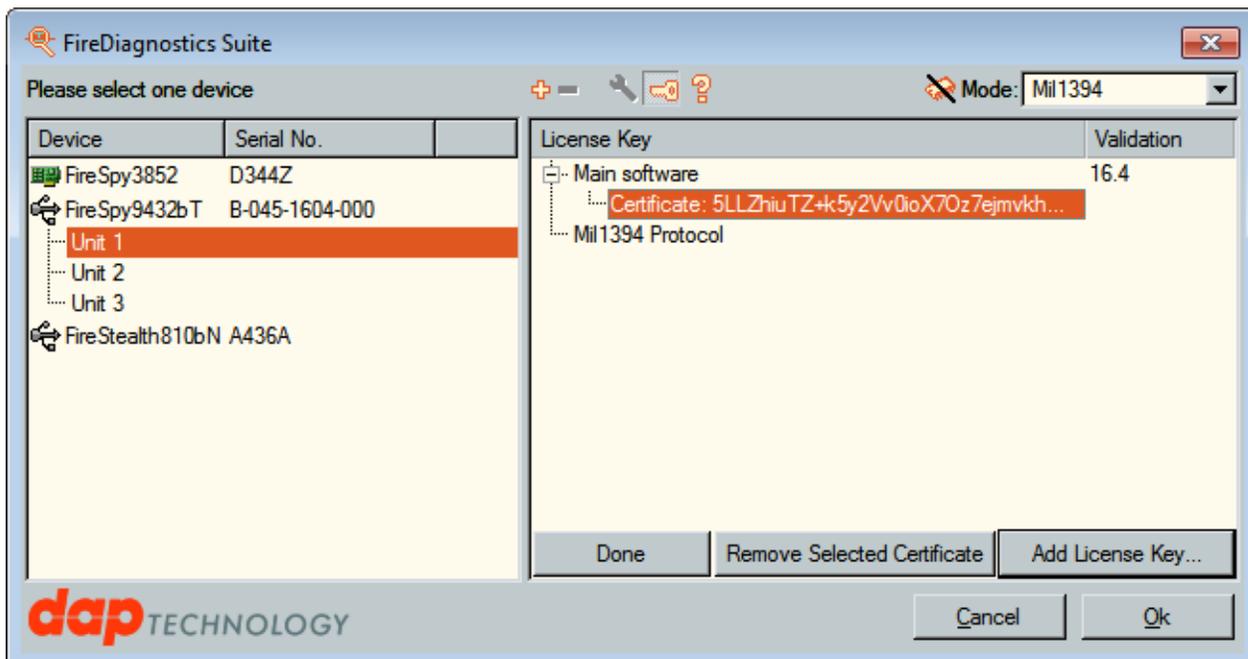
### License Management

You can enter the license configuration mode by clicking the toolbutton with the key icon, and go back to the device information mode by clicking it once again (or by clicking the 'Done' button). The license configuration mode shows the main license validation number and the licensed modules and their respective keys. In case of a temporary license, the number of days that the license will still be valid is also shown.

To add a new key, press the 'Add key...' button. This will pop up a dialog asking for a device serial number (which is already filled in when one device is selected) and a license key. To remove a key, expand the corresponding module in the tree view on the right, select the license key and press the 'Remove Selected Key' button.

It is possible to add or remove a license for a device that is not currently connected. In the license configuration mode, the left pane lists the licenses that have been registered by their serial number and a key icon. Disconnected ethernet devices are not shown. A serial can be added by clicking the 'Add key...' button and changing the serial number.

For further information about license configuration, see the [License Manager](#) manual.



### After Device Selection

If you installed the drivers correctly, the application will recognize the connected analyzer and start configuring it. After configuration, the analyzer is ready for use, the [Main Window](#) will be displayed.

### Multiple Applications Using the Same Analyzer

It is possible to open the same analyzer from within different applications, however, all main functions like the monitor, recorder, e.o. can only be opened once per analyzer. To prevent main functions from being opened by multiple applications, they are locked as soon as you start the corresponding window.

For example, it is possible to open two instances of the application, which both use the same analyzer. One instance could use the monitor and the other instance could use the recorder. Of course it would be easier to just start one instance of the analyzer application and just open the monitor and the recorder, but other applications using the FireDiagnostics Suite API may access the device as well.

### No License

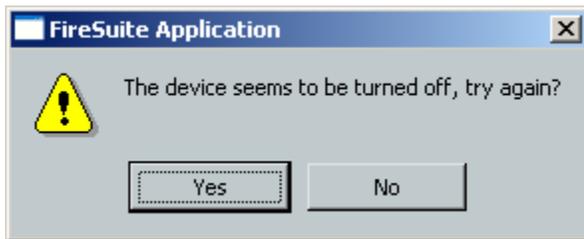
If you connected an analyzer correctly, but you have no license key installed with a validation number high enough to unlock this software version, the following message will be displayed: (validation number depends on software version)



Please click on the OK button. The application will continue without using an analyzer or return to the device selection dialog. You will need a license key for version 1 or higher to be able to work with a connected device. If you want protocol support, you will need a license key for version 2 or higher and a license key for each protocol you want to have supported. See the license management explanation above on how to install a license.

### Analyzer Turned Off

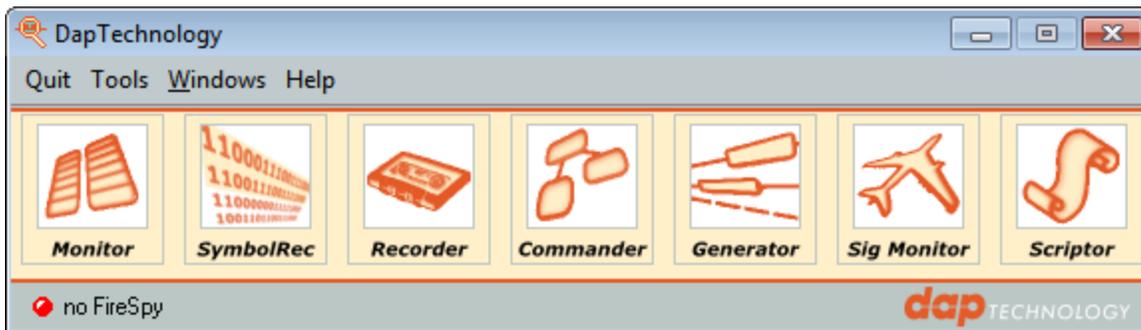
If you connected an analyzer, but it is not connected to the power supply or the power is switched off, the following message will be displayed:



You may now connect the power supply and/or switch the power on, and try again. Or you may choose to run the application without an analyzer.

## 4.2. Main Window

The main window consists of the menus and the control area. Below is a screenshot of the main window without a FireSpy connected. This shows all module buttons available. Please note that when used with a specific analyzer model some module may not be available.



### Menus

#### Quit

Exit the application by closing the main window or selecting 'quit' from the menu at the top of the main window. All windows from the same application instance will be closed.

#### Tools

From here you can open the Settings Dialog and the Filter/Trigger Settings.

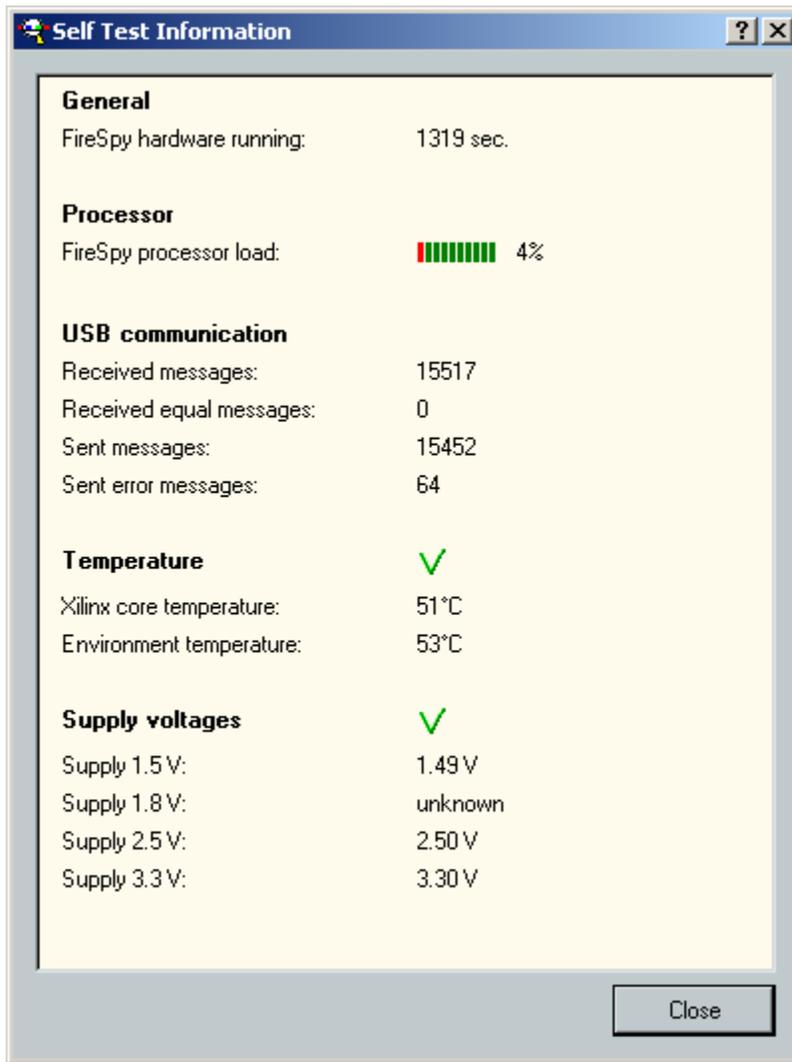
The [License Manager](#) is used to manage the possible licenses for the FireDiagnostics Suite. License keys can be added to unlock new features and protocol analyses.

#### Windows

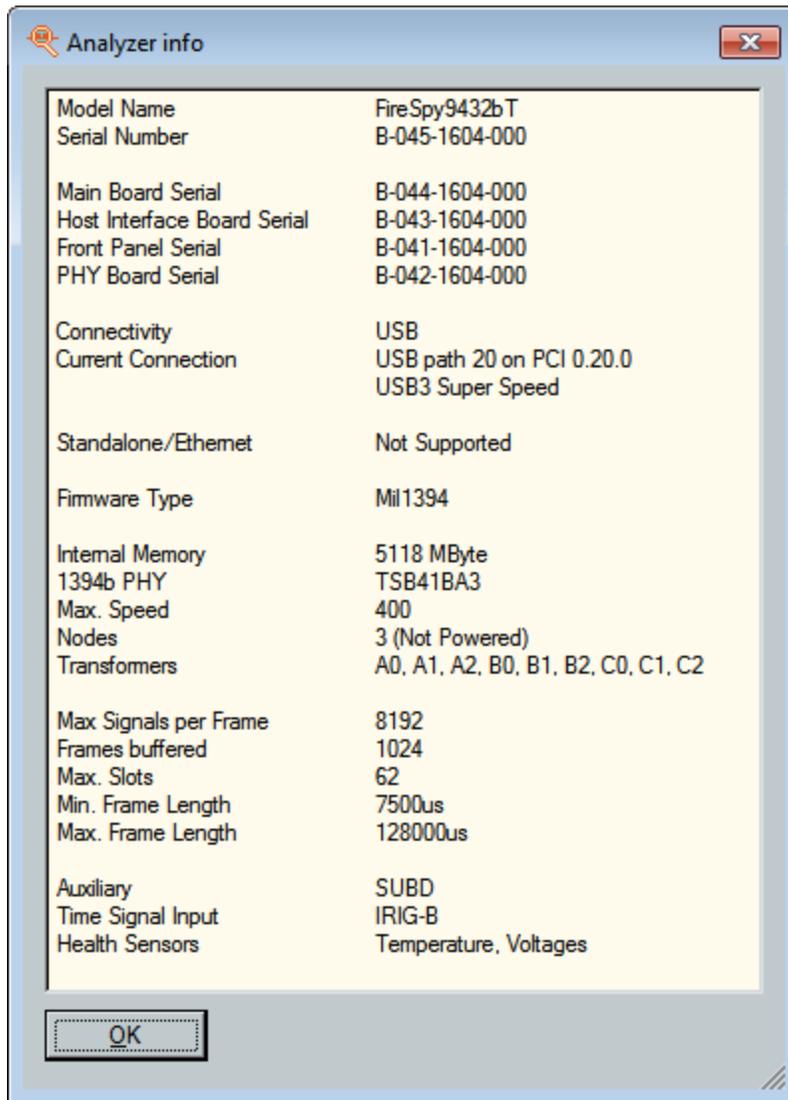
From the 'Windows' menu or the buttons in the main window area you can open the Monitor, Recorder, Generator, Commander and Scriptor, respectively.

#### Help

Using the 'About' command in the 'Help' menu you can get information about the hardware status and the current software version. It also displays the web site where to get additional information or to download new software versions and where to get support. To display the results of the Power-On Self Test and the current hardware status, select 'Self test Information' from the menu. The following dialog will be displayed:



Selecting 'Analyzer Info' from the Help menu opens a window with information about the analyzer(s) currently in use:



### Controls

The windows for the main functions (Monitor, Recorder, Generator, Commander and Scriptor) can also be opened by clicking on the corresponding button. The button will be highlighted when the mouse is positioned above it.

The led in the left-bottom corner will display the current configuration status. It can be:

- Gray, indicating that the analyzer is not yet completely configured.
- Green, indicating that the analyzer is configured successfully and ready for operation.
- Yellow, indicating a FireStealth analyzer that lost sync.
- Red, indicating that no analyzer was selected or configured successfully. In this mode, you still can open, save and analyze files.

## 4.3. Connecting to an IEEE1394 Bus

To analyze an IEEE1394 bus, you can connect one of the analyzer's IEEE1394 ports to any free port of an existing bus, or you may disconnect an existing IEEE1394 cable between two ports, and insert the analyzer in-between the two disconnected ports by using another cable.

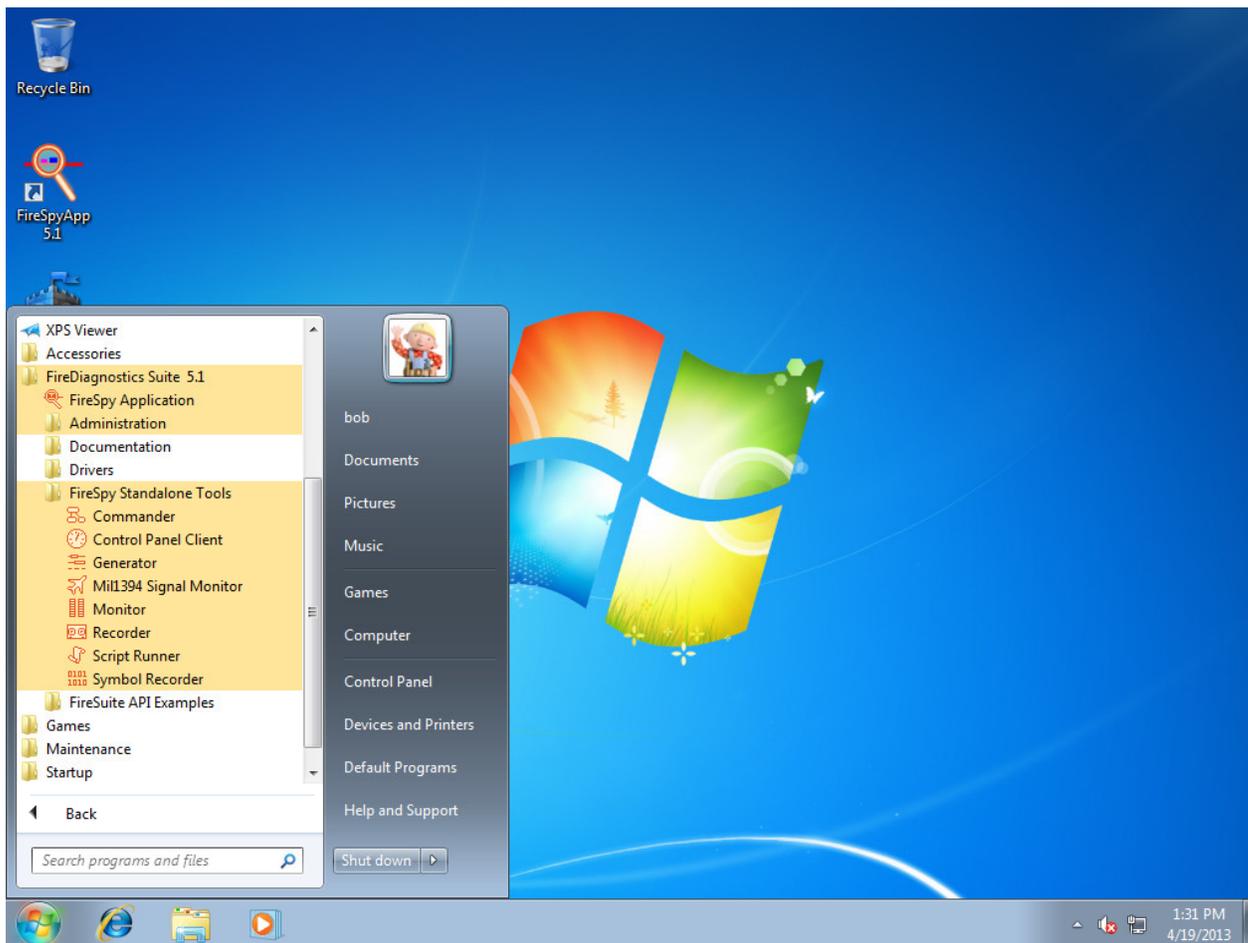
In both cases you should connect the analyzer to the existing bus such that it can 'see' all nodes at their full speed. If you connect the analyzer in such a way that some node has one or more connections between itself and the analyzer that has a speed lower than the maximum speed this node can handle, then some packet may not be picked up by the analyzer. The analyzer will detect a 'hidden' (or prefix only) packet instead, which are counted by the Monitor. The Recorder will know the duration of the hidden

packets, but it does not know at which speed the packet has been sent or how many bytes it consists of.

If you see the Monitor or Recorder detecting these packets, you can take a look at the topology view in the Commander to find the problem.

## 4.4. FireSpy Standalone Tools

In addition to the main FireSpy application with all main FireSpy modules embedded there is also a way to start each module as a standalone application. These standalone versions can be started through the Windows start menu and then navigating to "All Programs", "FireDiagnostics Suite X.X" and then "FireSpy Standalone Tools". The picture below shows where to find the standalone versions.



Multiple standalone FireSpy tools can be started at the same time, but each module can only be started once per FireSpy. The following standalone FireSpy tools allow controlling multiple FireSpy devices from within a single application:

- Recorder
- Monitor
- Symbol Recorder

All other modules only allow controlling one FireSpy device from a single application.

## Chapter 5. License Manager

To be able to use the software with a connected analyzer, you will need one or more license keys, at least for the 'Main Software', with the minimal version needed for the application. If the application is started with an analyzer selected, but without the appropriate license key, an error message will be shown and the application will continue without live analyzer support.

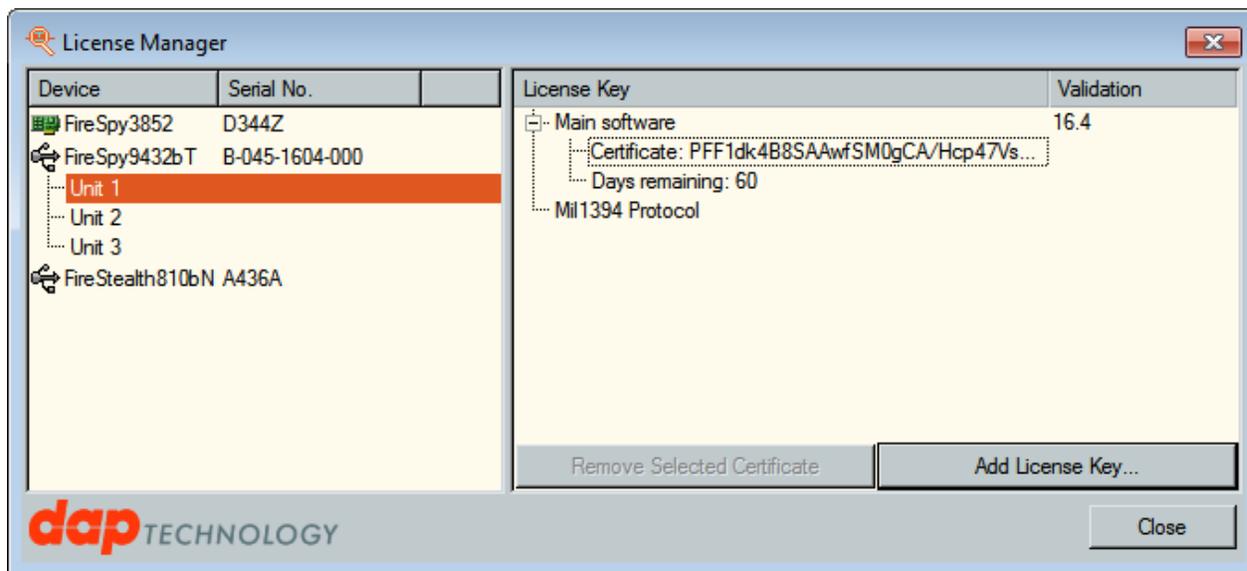
An additional license key is required for each higher-level protocol you want to use. The License Manager is used to install and remove such license keys. You can see which keys are installed and, if applicable, how many days it will remain valid.

License keys are linked to the serial number of the connected analyzer, so if the device is not connected, all license keys will be inactive and the related features will be disabled. However, when you open a recorder file in the Recorder that has been created using an analyzer with some installed license keys, all these license keys become active as long as you have loaded this file. Thus you will be able, for instance, to use the SBP protocol analyzer to analyze a recorder file made by somebody who used an analyzer with SBP license key, without having any license keys yourself.

### 5.1. How to use it

You can open the License manager dialog by selecting the 'License Manager' function in the 'Tools' menu of the Main Window. Or from the Windows Start menu at FireDiagnostics Suite -> Administration. Licenses can also be configured in the [Startup Dialog](#).

An example of the License Manager dialog window is shown below. In this example the serial number of one of the connected analyzer is B-045-1604-000. A license certificate is installed for this device which contains a 'Main Software (version 16.4)' license and a license for the Mil1394 protocol. The License certificate is only valid for another 60 days. The icons next to the serial numbers indicate the connection type (if connected) or whether it is a license for a device that is currently offline (key icon).



You can add keys with the 'Add License Key...' button or remove them by selecting a key and clicking the 'Remove Selected Key' button. You will need to restart the application to activate the new keys, except in the startup dialog; licenses added there can be immediately used.

Any existing keys for the same serial number and module will be permanently overwritten.

Please contact DAP Technology to obtain additional license keys.